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Steel Turret Track Castings

Methods and Equipment Adopted in Navy Yard Foundry for Molding, Pouring and Annealing Battleship Castings Designed To Meet Severe Chemical and Physical Specifications

BY S. W. BRINSON

ALL STEEL castings under 8 tons for the battleships INDIANA and SOUTH DAKOTA now building at the New York navy yard and the NORTH CAROLINA under construction at the Norfolk navy yard were made in the navy yard foundry at Norfolk, Va. Each of these ships has a displacement of 42,000 tons and is provided with four 3-gun turrets. A modern battleship carries only a few larger steel castings than the turret track castings and certainly none that are more important. In addition to the usual strains the turret track castings must resist an abrasive or rolling strain.

The track in effect is a huge ball bearing 36 feet in diameter with the races cored to the center in the top and bottom rings. Tapered flanged rollers are employed instead of balls. The severe service to which these tracks are subjected may be inferred from the fact that they are designed to support a revolving turret weighing approximately 1000 tons. In addition the recoil from

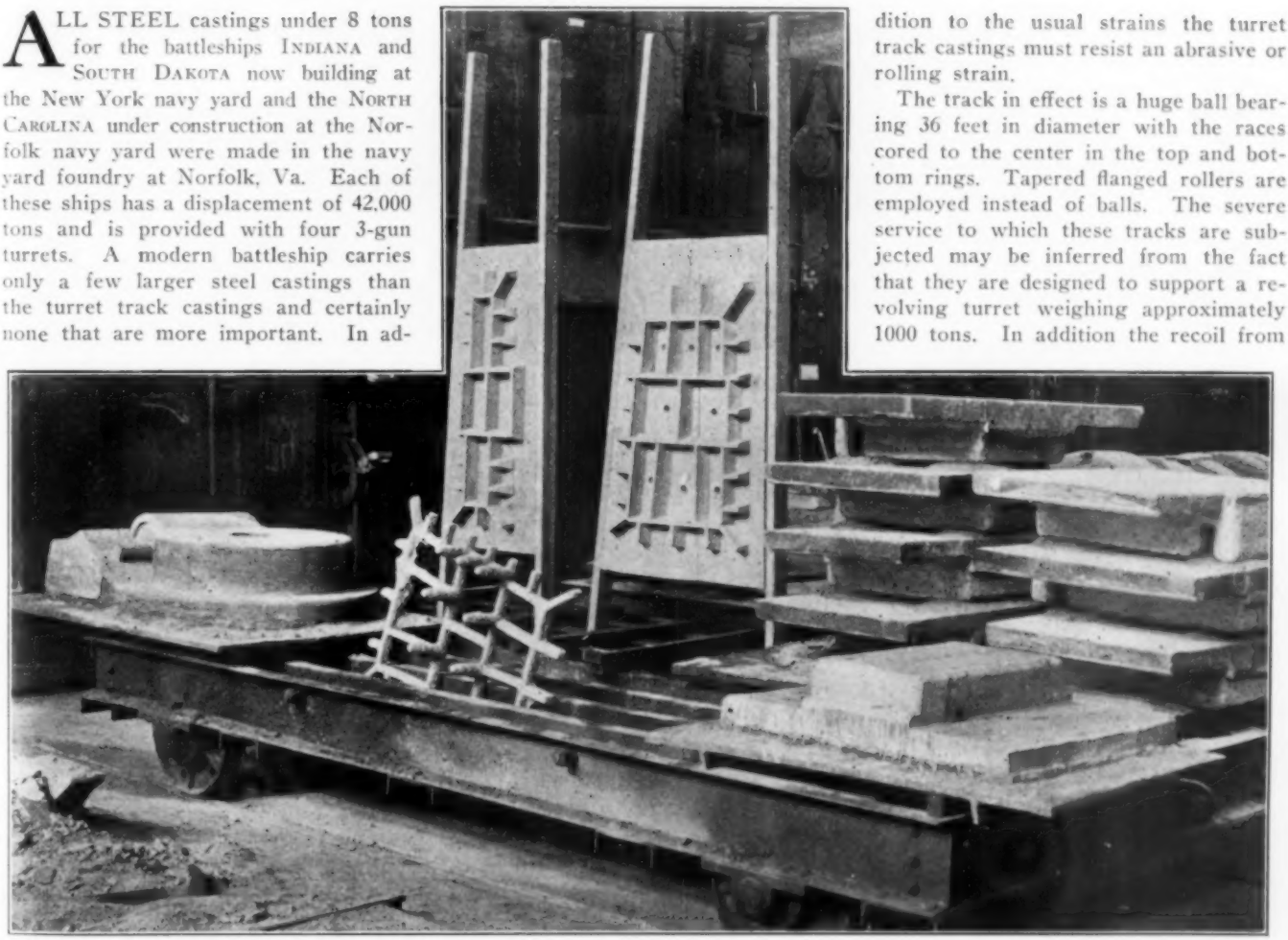


FIG. 1—THE PATTERNS FOR THE CORE ARBORS ARE MOUNTED ON BOARDS AND PRESSED INTO AN OPEN SAND BED UNTIL THE HANDLES REST ON THE STRAIGHT EDGES

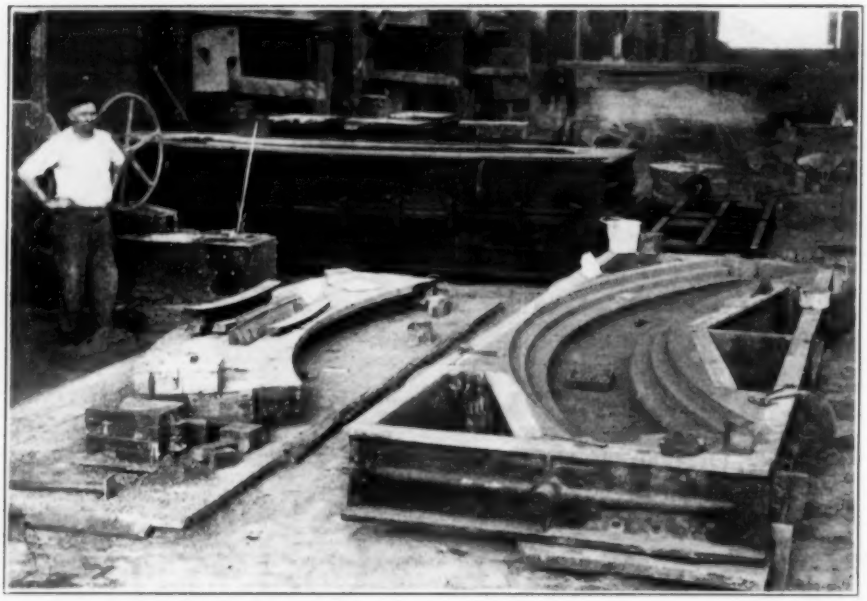


FIG. 2—PATTERN WITH LOOSE SIDE PIECES IS SHOWN TO THE LEFT, A DRIED MOLD IS ON THE CAR AND A PARTLY FINISHED MOLD ON THE FLOOR

three 16-inch guns fired simultaneously must be absorbed between the tracks and the rollers.

Other interesting details in connection with these castings are included in the information that the turret track is molded and cast in six segments and therefore 144 castings were required to fill the order for the three ships. The average weight of each casting was 9000 pounds or a total of 1,296,000 pounds of steel. A battleship, of course, is not built in a day and therefore an average speed of one casting a day maintained at the yard was ample to deliver the castings on schedule. Three molders and two helpers were engaged every day in making the mold and cores. One molder and one helper spent one half day in coring the mold and preparing it for the metal. The work was under the direct supervision of J. C. Pendleton, master molder, to whom most of the credit is due for the successful production of the castings.

One pattern served to make all the lower sections. It was a 60 degree segment and all the castings were alike. A gap was provided about half way between the center and one end of each segment as shown at *A* in Fig. 6 through which worn rollers may be removed and replaced. A pattern was provided to make the small casting designed to fill the gap.

Segments Not Alike

The top of the turret track also was made in six segments, but the segments were made of varying lengths so that under no condition would the upper joints coincide with the lower joints while the turret revolves. Two segments were made 57½ degrees. Individual patterns were made for each size.

A curved flask conforming in a general way to the shape of the casting was employed for making a few of the first castings. This special flask was designed to save sand and labor. It was formed of a 16-inch drag and a 6-inch cope. The original pattern was designed to form both upper and lower faces of the casting and the hanging body of sand was suspended from the cope.

After making a few castings in this manner the method was changed to that shown in the various illustrations. The cope was eliminated altogether and the back of the casting was formed by a number of cores supported on ledges on each side of the mold. The curved flask was difficult to handle and also was not sufficiently rigid. A new rectangular flask was constructed and fitted with stop-off bars as shown in Fig. 2. This type of flask was strong and rigid and in addition reduced the amount of sand and labor required to a minimum.

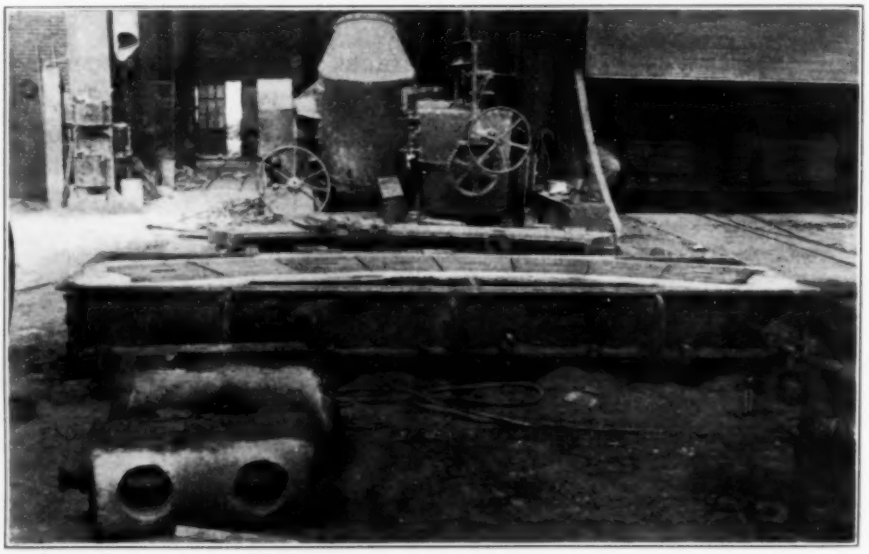


FIG. 4—MOLD AS IT APPEARED AFTER THE COVERING CORES WERE SET—RUNNER AND RISER BOXES ARE SHOWN FRONT

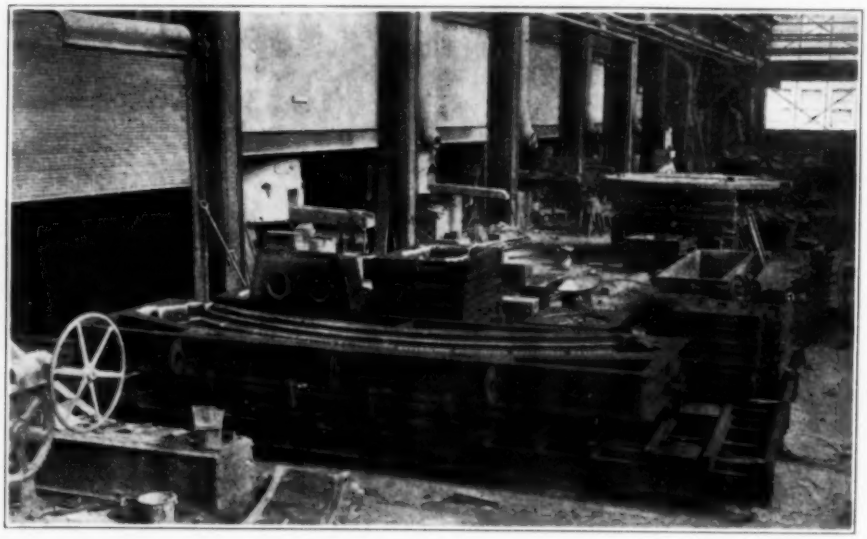


FIG. 3—DETAIL OF OVEN CAR WITH MOLD IN POSITION—THE MOLD IN FRONT OF THE THIRD CUPOLA IS FOR A BATTLESHIP FAIRWATER AND THAT TO THE RIGHT FOR A CONDENSER

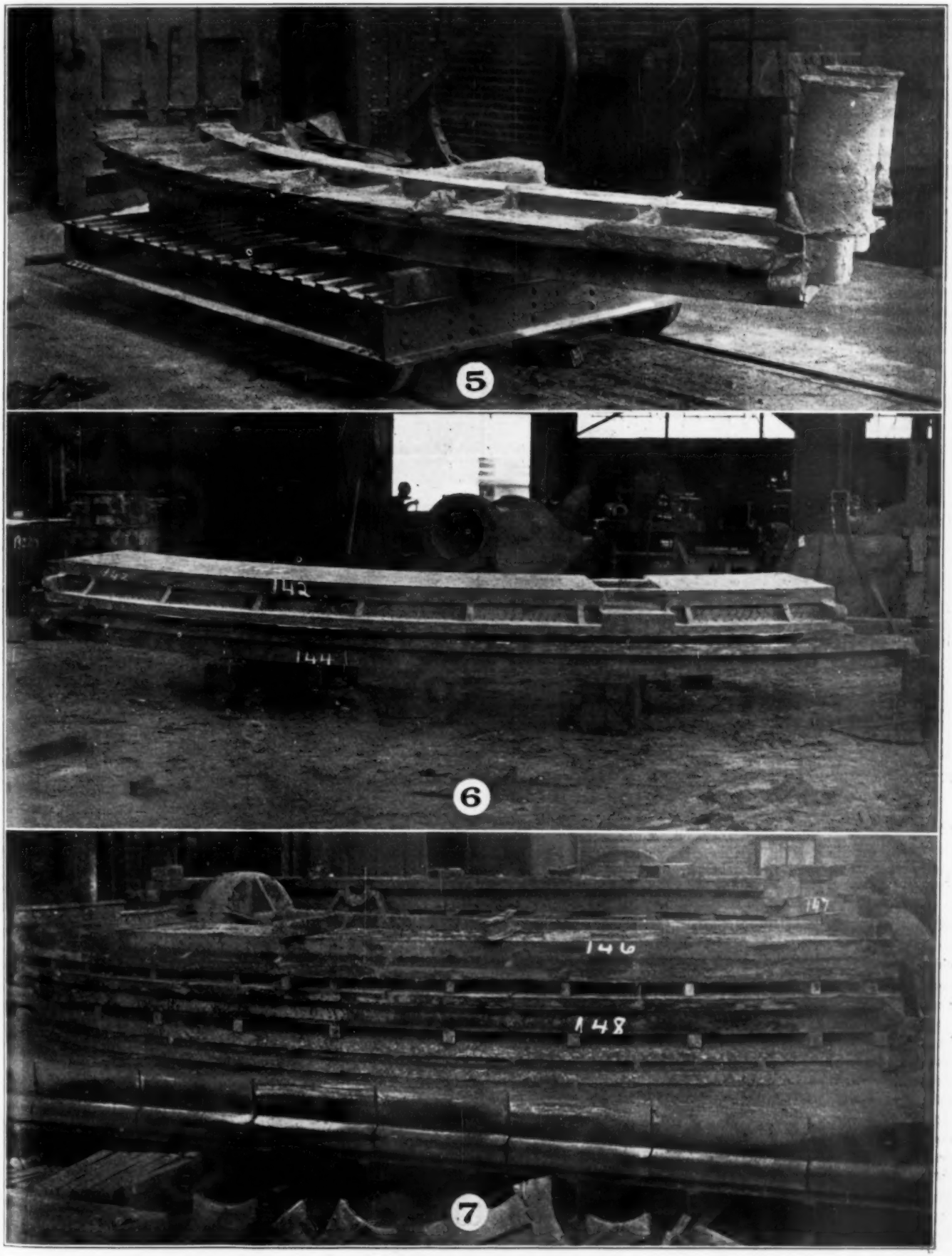


FIG. 5—(ABOVE) ONE OF THE 62½ DEGREE TOP TRACK CASTINGS AFTER IT WAS TAKEN FROM THE MOLD. FIG. 6—(CENTER) TYPICAL TOP AND BOTTOM TRACK CASTINGS. THE BOTTOM CASTING IS ON TOP IN THE ILLUSTRATION FIG. 7—CAST IRON SPACERS WERE PLACED BETWEEN THE CASTINGS ON THE ANNEALING CAR

A new pattern, full size, solid and provided with loose pieces along both sides to form the overhang was placed back down on a bottom board. The flask was placed around the pattern, filled with sand, rammed and rolled over. The pattern was bolted to the bottom plate and therefore it was not necessary to clamp the pattern board to the flask before it was rolled over. The bolts were released after the drag had passed the perpendicular on its rolling over arc.

After the drag was leveled the main part of the pattern was lifted out of the sand, leaving the loose side pieces to be drawn in afterward. On the first castings the six test bars were placed on the flange formed by the loose pieces, but afterward their location was changed to the face of the casting. In Fig. 2 the mold is shown partly finished. After the surface was nailed and slicked it was covered with a wash made from dust collected in the vicinity of the sandblast machines. This wash has given excellent results and has been used exclusively in the navy yard foundry on steel castings for the past three or four years.

The molding sand contains a natural bond and is procured in the vicinity of Richmond, Va. The sand is run through the mixer without the addition of any other material and then is suitable for the general run of work. It has been employed continuously in the navy yard foundry for the past four years with satisfactory results. This sand also has given satisfactory service on iron castings and was used on several of the navy type gas engine castings. For iron castings it is mixed with old molding sand in the same manner and proportioned as any new sand.

After the mold was washed it was placed on a car as shown in Fig. 3 and placed in the drying oven for 24 hours. A mold for a cast steel fairwater is shown back of the turret track in Fig. 3 and a partly completed loam mold for a condenser head is shown further back in the same illustration.

Gates And Risers

The mold was taken out of the oven the day is was to be poured. It was leveled on the floor and then the cores were placed in position. One of the top track castings with cores and gates and risers in place, is shown in Fig. 8. A cast-iron plate was clamped on top of the cores to hold them in place during the pouring process.

The covering cores were made from a mixture of one part fire clay and 30 parts of the molding sand employed for facing sand in the mold. They were washed with the same material used on the mold. They were made in the core room and dried in the core ovens. A number of the cores and also one of the crabs or core arbors are shown in Fig. 1. The patterns employed for making the crabs are shown in the same illustration. In making the crabs a sand bed was prepared in a space bounded by cast-iron plates. The coremaker and helper, walking one on each side of the bed, placed the pattern in position and then rapped it down until the handles rested on the iron plates. The process was repeated until a sufficient number of molds were prepared. The holes shown in the board provide for the escape of air as the board was forced down against the sand. After the pattern was withdrawn a round stick was forced down at various points to form dabbers on the arbor along the center. This method has been practiced extensively in the yard on jobs requiring any considerable number of arbors.

The castings were poured from steel conforming to the following specifications Navy Grade *A*:

Steel Specifications.

Phosphorus 0.05 maximum.

Sulphur 0.05 maximum.

Minimum tensile strength 80,000 pounds per square inch.

Minimum yield point, 45 per cent of tensile strength.

Minimum elongation, 17 per cent in 2 inches.

Minimum reduction in area, 20 per cent.

Cold bend about 1-inch diameter, 90 degrees.

Steel for the castings was melted in a 6-ton Greaves-Etchells electric furnace made by the Electric Furnace Construction Co., Philadelphia. The metal was poured through a single gate at one end from an 8-ton bottom pour ladle. Four 12-inch risers 20 inches high were placed on the top castings. Two additional risers the same dimensions were placed one on each side of the gap in the bottom castings. The gate was about 4 square inches in cross sections and extended to the bottom of the mold. The mold was poured almost full through the gate and then the risers were filled directly from the top and covered with charcoal to keep them liquid as long as possible.

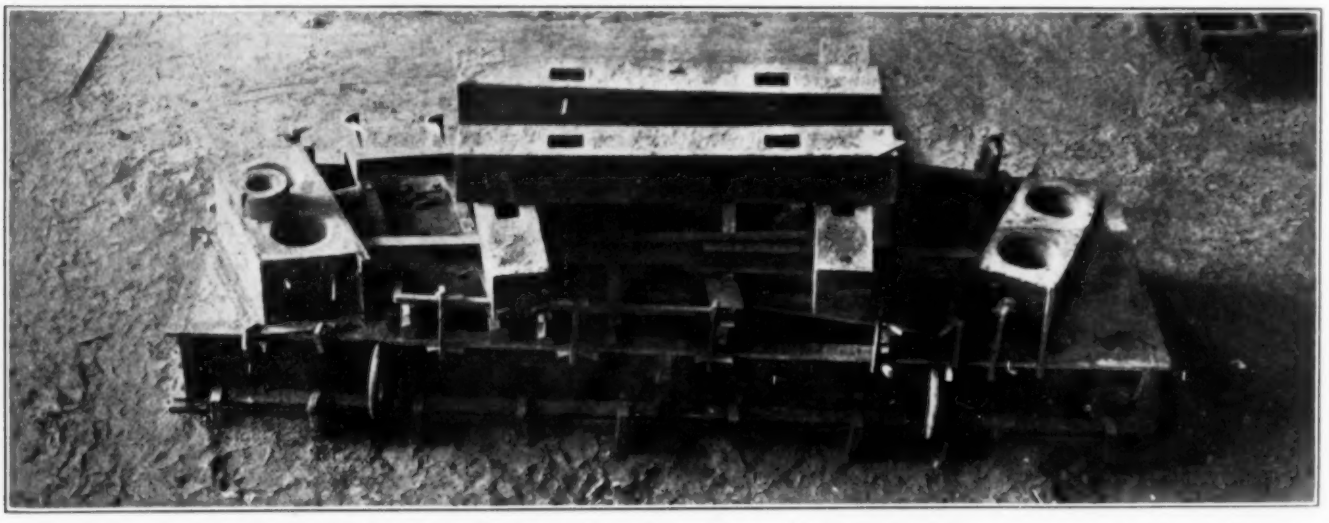


FIG. 8—ONE OF THE COMPLETED MOLDS READY FOR THE METAL. AN IRON PLATE WAS CLAMPED AND WEIGHTED ON TOP OF THE COVERING CORES

To meet the physical specifications, steel was melted to the following approximate analysis: Carbon 0.40 per cent; manganese 0.70 per cent; silicon 0.25 per cent. No trouble was experienced in keeping below the specified maximum sulphur and phosphorus content of 0.05 per cent. A typical analysis of a track castings follows:

Carbon, 0.376 per cent.

Manganese, 0.734 per cent.

Silicon, 0.302 per cent.

Phosphorus, 0.025 per cent.

(*Concluded on page 664*)

Will Award Medals for Achievements

DISTINGUISHED service to the foundry industry is to be recognized through the presentation annually of medals made possible by the establishment of four award funds of $5000 each donated by W. H. McFadden, J. H. Whiting, John A. Penton and the late Joseph S. Seaman, during the convention in Columbus, O., in 1920. The board of administration of these funds, comprised of seven past-presidents of the American Foundrymen's association announces the first presentation of the John A. Penton medal to Enrique Touceda for notable accomplishments in the technical phases of malleable castings manufacture. John Howe Hall is to receive the J. H. Whiting medal for outstanding achievements in the metallurgy of steel castings production. The presentation of these medals will be made at a special session of the association during the 1924 convention.

Enrique Touceda

ENRIQUE TOUCEDA was born in Cuba in 1866 and received his preliminary education in private schools. He spent four years at Georgetown university, Washington, D. C., then studied at Rensselaer Polytechnic Institute, Troy, N. Y. from which he graduated in 1887 with the degree of civil engineer. His plant experience includes several years with the Troy Steel & Iron Co., Troy, N. Y. in various capacities, finally chief chemist and metallur-

ENRIQUE TOUCEDA

gist. This plant was one of the first to operate under the patents of Sir Henry Bessemer and was built by the eminent engineer, Alexander Holley. During his experience with this and other companies, Professor Touceda did some consulting work and in 1898 established chemical and physical laboratories in Albany N. Y. and went into business for himself as a consulting metallurgical engineer. A few years later he was appointed to the professorship of metallurgy at the Rensselaer Polytechnic institute, which he still holds in conjunction with his consulting work.

In 1912 he became consulting engineer for the American Malleable Castings association, and developed its standards. At present requirements of certified malleable are that it shall have a tensile strength of not less than 50,000 pounds per square inch and 10 per cent elongation in 2 inches, which illustrates the progress which has been made.

Professor Touceda is a member of the American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, Society Automotive Engineers, American Society for Testing Materials, American Iron and Steel institute, British Iron and Steel institute, American Society for Steel Treating, American Foundrymen's association, American Chemical society, and honorary member of the Institute of British Foundrymen.

His work on committees of various technical societies has been extensive and valuable. Some of the more recent include vice chairman of iron and steel committee, American Institute of Mining and Metallurgical Engineers, chairman malleable iron committee of American Foundrymen's association and committee on ferrous metals advisory to the bureau of standards. Last year he delivered the exchange address for the American Foundrymen's association at a meeting of the Institute of British Foundrymen at Birmingham, England.

John Howe Hall

JOHN HOWE HALL was born June 20, 1881, at South Portsmouth, R. I., and received his early education in the schools of New Jersey. He was graduated from Harvard college in 1902, and received his master's degree from the Harvard graduate school in 1903. While doing further graduate work at Harvard, he specialized in metallurgy under Prof. Albert Sauveur, investigating vanadium steels. Mr. Hall then became connected with the Bethlehem Steel Co., working in various positions, finally being made assistant superintendent of the crucible steel department.

Upon leaving the Bethlehem company in 1906, he worked for a short time with the Buffalo Crucible Casting Co., afterwards going to the Taylor-Wharton Iron & Steel Company, High Bridge, N. J., as metallographist, where in 1911 he was placed in charge of steel making and heat treatment.

After two years in New York as a consulting engineer, Mr. Hall was employed by the Quigley Furnace & Foundry Co., Springfield, Mass., to investigate properties of semi-steel and oxygenated iron. He then returned to the Taylor-Wharton company, where he is at present metallurgist for this organization's High Bridge and Easton, Pa. plants.

Mr. Hall has been active in technical committee work, being at present secretary of American Society for Testing Materials committee A-4 on heat treatment of iron and steel, and serving on this so-

JOHN HOWE HALL

ciety's committees on metallography, foundry pig iron, and steel. He is secretary of the iron and steel committee of the American Institute of Mining and Metallurgical Engineers, is a member of the American Foundrymen's association committee on specifications for steel castings and represents the National Research council on the joint committee investigating the influence of phosphorus and sulphur in steel.

Mr. Hall contributed the chapters on crucible steel and bessemer steel in the well-known book, "ABC of Iron and Steel." He has presented numerous papers at the annual meetings of the American Foundrymen's association, Institute of Mining and Metallurgical Engineers, the Society of Chemical Industry and others.

Merge World Foundry Thought

Paris International Congress of Foundrymen Draws Interest of Entire Industry—Seek Common Ground for Comparison of Iron —Extensive Exhibition Planned

PARIS, queen of Europe and city of a thousand splendors, is not only a great political, artistic, and sightseeing center, as everyone knows, but also a city of solid commercial and industrial achievement, representative of the engineering and business leadership of twentieth century France. This will be demonstrated to foundrymen the world over next month when the International Foundrymen's congress, which will be held in Paris Sept. 12 to 16 under the auspices of the Association Technique de Fonderie de France, takes place. Casting manufacturers from all over the world will journey to France to attend this event and visit the exhibition of foundry and shop equipment which will be held at the same time. It is expected there will be at least a thousand visitors to the combined functions which will occupy the first two weeks in September. A special delegation has been organized by the American Foundrymen's association, to leave New York on the United States shipping board liner LEVIATHAN, Aug. 18. This party, which is expected to number at least 50, will be headed by G. H. Clamer, Ajax Metal Co., Philadelphia, president of the American Foundrymen's association, supported by several directors and other officers. Before and after the Paris meeting the American delegation will tour England, France, and Belgium, where they will be officially received by the British, French and Belgian foundrymen's organizations, as outlined in detail in the July 1 issue of THE FOUNDRY. The Institute of British Foundrymen is also organizing a special party to attend the Paris convention. This delegation is expected to number over 100. It will be headed by Oliver Stubbs, Joseph Stubbs Ltd., Manchester, president of the institute, accompanied by numerous other officers and members of

The British delegation will travel to Paris on Tuesday, Sept. 11, with the members of the American Foundrymen's association. A number of members of the British Iron and Steel institute will stop off in Paris enroute to the fall meeting of this society which is being held in Italy. It is also expected that a delegation representing the British Institute of Metals will go to Paris after the conclusion of the fall meeting of this organization in Manchester.

The Mecca of Foundrymen

In addition to these organized bodies of foundrymen, a large number of individual visitors are expected, representing practically every country in the world outside of the former central empires. Paris will be the foundrymen's Mecca in September.

Plans for the congress are now well advanced. The proceedings will be opened at 10 a. m. Wednesday, Sept. 12, by a representative of the French government. Subsequent to the opening session, meetings will be held for the reading and discussion of papers in the forenoon of each of the three following days. The afternoon will be devoted to visiting points of interest in Paris and to the inspection of foundries in the Paris district. A group of papers and reports in English, presented on behalf of the American Foundrymen's association and the Institute of British Foundrymen, will be read Thursday morning, Sept. 13. The remainder of the proceedings will be in French. The papers committee of the French association, which is headed by E. Ronceray, has prepared an unusually interesting and valuable program. Papers will be presented dealing with all branches of foundry practice, fully describing and illustrating the latest European foundry methods. The program will be featured by a discussion of tests for cast iron with a view to reaching international agreement on this important subject. French malleable founders have reached a high stage of development and this feature of the proceedings also will be important.

The entertainment program, details of which were published in The Foundry July 1, is both complete and interesting, and an unusually good opportunity to study French foundry methods will be offered. The interallied foundrymen's banquet which will be held Saturday evening, Sept. 15, will be an unusually brilliant affair at which addresses will be made by representatives of the various foreign delegations.

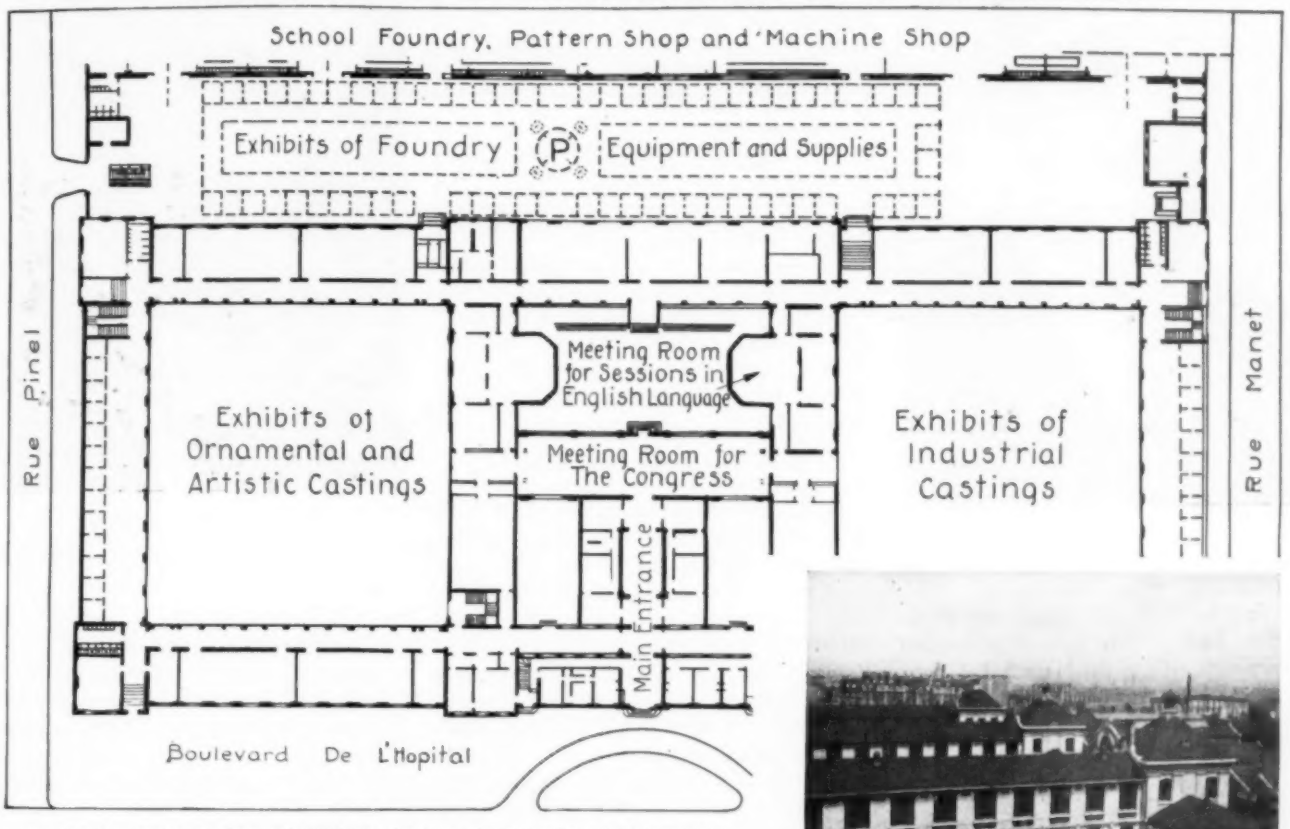
All of the proceedings will be centered at the Ecole des Artes et Metiers School of

GUILLIAM H. CLAMER AND EMILE RAMAS

M. Ramas, President of the Association Technique de Fonderie de France, Journeyed to Cleveland in April to Present the Invitation of his Organization to the American Foundrymen's Association, in Response to Which a Delegation Sails Aug. 18 Headed by President Clamer, to Attend the Paris Meeting

Exhibitors at the Paris Foundry Exposition

TENTATIVE LIST OF MANUFACTURERS TO BE REPRESENTED



PLAN OF THE PARIS FOUNDRY SHOW, SHOWING EXHIBITION HALL AND MEETING ROOMS—RIGHT—INNER COURTYARD OF ECOLE D' ARTS ET METIERS WHERE THE EXHIBITION WILL BE HELD

ABRASIVE INDUSTRY, Cleveland, Ohio; 23 Rue de la Bienfaisance, Paris; and Caxton House, London, S. W. 1—Original photos of American foundry methods. Technical books and periodicals. Business news bulletin by cable from U. S. A. Rest room for visitors.

ALLIED MACHINERY CO. DE FRANCE, 19 Rue de Rocroy, Paris—Molding machines and general foundry equipment. Representative of the Osborn Mfg. Co., Cleveland. Machines will be shown in operation.

STE. L'AVEBENE, 13 Rue d'Agueseau, Paris—Foundry supplies.

ALFRED BAILLOT & CO., RUE Alphonse Helbronner, Saint-Ouen, Seine—General foundry supplies and equipment.

STE. DES FONDERIES DE BAYARD ET ST. DIZIER, Bayard, Haute-Marne—Castings for building construction, ornamental castings, etc.

PH. BONVILLAIN & E. RONCERAY, 3 Rue Paul Carle, Choisy-le-Roi, Seine—Hydraulic molding machines, pattern plates, and general foundry equipment. Machines will be shown in operation.

BRITISH & CONTINENTAL TRADERS, LTD., Brownlow House, 50-51 High Holborn, London—Pig iron for gray iron and malleable foundries and for steelworks. Coke, refractories, etc.

CASTER, 57 Rue de la Folie Regnault, Paris—Foundry supplies.

COMPTOIR D'AGENCIES INDUSTRIELLES, 11 Rue La Boetie, Paris—Manufacturers' agents.

COMPTOIR GENERAL D'USINES, 46 Rue de la Bienfaisance, Paris—Pig iron and coke for foundries. Representative of British Pig Irons, Ltd.

J. CURY FILS ET MARTIN, Deville, Ardennes—Castings for automobiles, machine tools, etc.

DAILY METAL TRADE, Cleveland, Ohio; 23 Rue de la Bienfaisance, Paris; and Caxton House, London, S. W. 1—Original photos of American foundry methods. Technical books and periodicals. Business news bulletins by cable from U. S. A. Rest room for visitors.

PHILIPPE DANNELY, 31 Rue Racine, Montrouge, Seine—Tools for foundrymen. Bronze castings.

EMILE DEGREMONT, Le Cateau, Nord—Ladles, scales, etc.

STE. D'ELECTRICITE MORS, 11 Rue Petit, Clichy, Seine—Electrical equipment for foundries.

M. ESTIGNARD, 95 Boulevard Dayout, Paris—Metal for patterns, match-plates, etc.

FENWICK FRERES & CO., 8 Rue de Rocroy, Paris—Molding machines and foundry equipment. Representative of the Tabor Mfg. Co., Philadelphia. Machines will be shown in operation.

THE FOUNDRY, Cleveland, Ohio; 23 Rue de la Bienfaisance, Paris; and Caxton House, London, S. W. 1—Original photos of American foundry methods. Technical books and periodicals. Business news bulletins by cable from U. S. A. Rest room for visitors.

GAILLEY FRERES & CO., Rue de l'Abreuvoir, Charleville, Ardennes—Malleable castings.

GERNELLE-DANLEY & CO., 32 Rue du Mail, Rouen, Seine-Inferieure—Sand mixing machinery. Mold blackings.

GLAENZER & PERREAUD, 18-20 Faubourg du Temple, Paris—Molding machines and auxiliary equipment.

STE. METALLURGIQUE DE GORCY, 2 Rue de Constantinople, Paris—Gray iron and chilled iron castings.

GUILLIET FILS & CO., Paris—Woodworking machinery and patternshop equipment.

ETABLISSEMENTS HENRY HAMELIE, 21-23, Boulevard Jules-Ferry, Paris.—General equipment for factories.

ETABLISSEMENTS A. HUARD, 53-59 Rue des Perichaux, Paris—Grinding machines and grinding wheels for foundry purposes.

IRON TRADE REVIEW, Cleveland, Ohio; 23 Rue de la Bienfaisance, Paris; and Caxton House, London, S. W. 1—Original photos of American foundry methods. Technical books and periodicals. Business news bulletins by cable from U. S. A. Rest room for visitors.

RENE JADIRAT, 50 Rue de Moscou, Paris—Refractory products for foundries.

T. KETIN & F. THIRIART, Rue Paul Jansen a Sclessin-lez-Liege, Belgium—Sand mixing and preparing machinery. General foundry equipment.

KITTEL & CO., LTD., 8 Rue de

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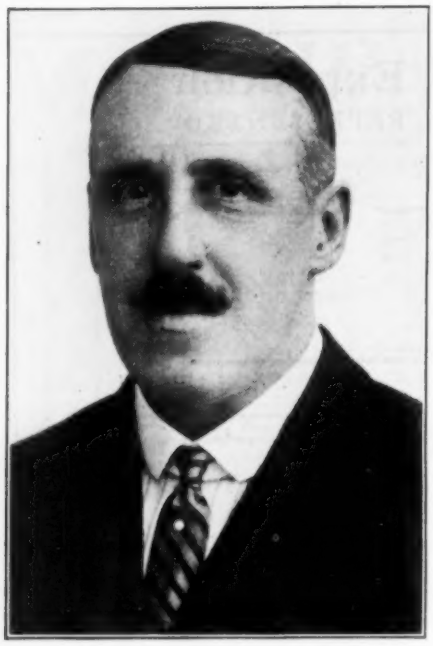

OLIVER STUBBS
President of the Institute of British Foundrymen

Papers in English

English Session, Sept. 13

Contributed by A. F. A.

"The Bonding Substance of Molding Sand; Its Composition, Properties, and Tests," by H. B. Hanley, foundry engineer, Arnett building, Rochester, N. Y. (Official exchange paper.)

"Testing Cast Iron," by Dr. Richard Moldenke, Watchung, N. J.

Contributed by I. B. F.

"Magnesium in Foundry Practice," by H. J. Meybury, chief metallurgist, Magnesium Co., Ltd., London.

"Cast Iron," by Oliver Smalley, foundry manager, Sir W. G. Armstrong-Whitworth & Co., Ltd., Newcastle-on-Tyne.

Arts and Sciences 151 Boulevard de la Hopital, Paris. The school is located on the south side of the river Seine, near the famous Luxembourg district. It is unusually well equipped for both convention and exhibiting purposes.

The exhibition which will be held at the school along with the convention, has been organized by the Association Technique de Fonderie. It will open Sept. 2 and close Sept. 16. By the end of July over 50 exhibitors already had been secured and before the opening day it is expected this number will at least be doubled. A list of the principal exhibitors with details of their displays is presented herewith.

Both Useful and Beautiful

It is expected that this exhibition will not only be one of the most complete of its kind ever presented in Europe, but one of the most beautiful and artistic as well. As indicated on the accompanying plan, the exhibits will be staged in the three courtyards around which the school buildings are grouped. To the right of the main entrance will be displayed industrial castings of all sorts from the largest to the smallest. In a similar court to the left will be found exhibits of artistic castings, in the production of which French foundrymen are pre-eminent. The long central courtyard shown on the top of the plan will be utilized for the exhibition of foundry and shop equipment, the still exhibits being arranged in booths around the walls with the operating exhibits in the center. Immediately back of this central courtyard are the school shops, including a fully equipped foundry, pattern shop, laboratories, etc. These will also be available for the demonstration of operating methods and industrial processes.

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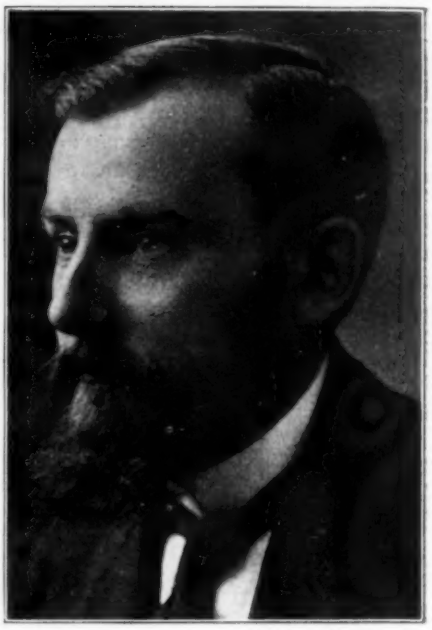

DR. JOSEPH LEONARD
President of the Technique de Fonderie de Liege, Belgium

Exhibitors at the Paris Foundry Exposition

TENTATIVE LIST OF MANUFACTURERS TO BE REPRESENTED

(*Concluded from Page* 651)

Madrid, Paris—Pig iron, coke, coal and refractories.

ETABLISSEMENTS LADREYT, 182 Boulevard Victor-Hugo, Clichy, Seine—Foundry supplies and equipment.

LARDIN & CO., 79 Rue de Crimee, Paris.—Tools for molders. Foundry supplies.

H. M. LANE CO., 333 State street, Detroit, Mich.—Foundry designs and construction data. Complete installations. Core room equipment.

LEES SHIPPING & TRADING CO., 2 Quai Ortelius, Antwerp, Belgium—Pig iron for foundries.

A. MARILLIER, St. Loup-sur-Semouse, Haute-Saone—Molding machines and general foundry equipment.

STE. MECANIQUE-MODERNE, 9 Boulevard Lobau, Nancy, Meurte-et-Moselle—Castings and machine shop products.

STE. DES FONDERIES MODERNES POUR L'AUTOMOBILE, Rue Edouard Vaillant, Bondy, Seine—Castings for motor cars, trucks and tractors.

MONTUPET & CO., 11 Boulevard Lannes, Paris—Aluminum castings.

FONDERIES ET ATELIERS DE NORD-PARIS, 66 Boulevard Pasteur, La Courneuve, Seine—Castings for industrial purposes.

STE. ANE. D'OUGREE-MARIHYE, Ougree, Belgium—Chilled-iron rolls and steel castings.

STE. PARISIENNE DE MATERIAL DE FONDERIE, 122 Avenue de la Republique, Paris—General foundry supplies.

J. W. PENICUD, 78 Avenue du General Michel Bizot, Paris—Furnaces and refractories.

PENTON PUBLISHING CO., Cleveland, Ohio; 23 Rue de la Bienfaisance, Paris; and Caxton House, London, S.W.1—Publisher of THE FOUNDRY, *Iron Trade Review*, *Daily Metal Trade*, *Abrasive Industry*, *Marine Review*, and *Power Boating*. Original photos of American foundry methods. Technical books and periodicals. Business news bulletins by cable from U. S. A. Rest room for visitors.

STE. METALLURGIQUE DU PERIGORD, 43 Rue de Clichy, Paris—Pig iron.

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Foundry Costs Simplified--V

Methods for Arriving at and Distributing Indirect Expense Are Explained under Individual Headings—Expense Orders Classified Numerically—General Expense Determined on an Annual Basis for Distribution

BY ALFRED BARUCH

INDIRECT expense is the biggest problem in cost keeping. It is particularly difficult to determine just what portion of the expense must be borne by each department. To effect an equitable distribution all expenses that recur periodically are given an expense order number which identifies the expense with the department that incurs it. These expense orders are classified on a numerical basis and each figure in the order number has special significance. For example, all expenses connected with melting are numbered from 100 to 200. All labor melting expenses run from 100 to 120. All suppplies run from 120 to 150, etc. The following tables list the expenses by departments and by order numbers.

MELTING COST

Labor		Monthly	
100	Foreman (10 per cent of foundry foreman's wages)	$ 22.50	
101	Furnace loaders	400.00	
102	Melter (225 hours at 75c)	168.75	
103	Engineer (40 hours at 60c)	24.00	
104	Yard man (450 hours at 40c)	180.00	
	Total		$ 795.25
Supplies			
120	Coke	540.00	
121	Brick	20.00	
122	Clay	24.00	
123	Kerosene and wood	27.00	
124	Limestone	17.00	
125	Lining materials	37.50	
126	Fire sand	45.00	
	Total		710.50
Apportioned Expenses			
	Compressed air (2 per cent of $450.00)	9.00	
	Heat (14 per cent of $270.00)	37.80	
	Power (4 per cent of $600.00)	24.00	
	General expense (3½ per cent of $2400.00)	84.00	
	Total		154.80
	Total melting cost		$ 1,660.55

These figures are based on the assumption that the cupola melts 10 tons a day six days a week. At this rate it would melt an average of 250 short tons or 500,000 pounds of iron per month. To get the cost of melting per pound it is necessary to divide the $1660.55 by 500,000 which gives a melting cost of $.0033 per pound. To this must be added the cost of pig iron and scrap per pound to determine the cost of metal at the spout.

COREMAKING BURDEN

Labor		Monthly	
200	Supervision (20 per cent of the foreman's time)	$ 45.00	
201	General help (225 hours at 40c)	90.00	
	Total		135.00
Supplies			
210	Small tools	1.00	
211	Fuel	20.00	
212	Sand (10 tons at $3.00)	30.00	
213	Oil (50 gallons at 75c)	37.50	
214	Molasses (¼-barrel at $9.00)	2.25	
215	Rods, wire, nails, etc.	9.00	
216	Vent wax	.50	
	Total		100.25
Apportioned Expenses			
	Heat (3 per cent of $270.00)	8.10	
	Light (3 per cent of $200.00)	6.00	
	General expense (5 per cent of $2400.00)	120.00	
	Total		134.10
	Total coremaking burden		$ 369.35

The burden is applied on the basis of productive hours in a department. We will say arbitrarily that five men work in this department. At 8 hours per day this gives 1000 productive hours per month, which when divided into $369.35 gives an hourly rate of 37c.

MOLDING BURDEN

Labor		Monthly	
300	Foreman (70 per cent of $225.00)	$ 157.50	
301	Cutting sand and preparing floors (4 men)	700.00	
302	Pattern makers (2 men)	270.00	
303	General help (8 men)	780.00	
304	Special help (engineer)	40.00	
	Total		1947.50
Supplies			
320	Molding sand (25 tons at $5.50)	137.50	
321	Flasks, wood	500.00	
322	Small tools	50.00	
323	Nails	5.00	
324	Parting (2 barrels at $16.00)	32.00	
325	Plumbago (1 barrel at $27.00)	27.00	
326	Chaplets	1.50	
327	Miscellaneous supplies	10.00	
	Total		763.00
Apportioned Expenses			
	Compressed air (10 per cent of $450.00)	45.00	
	Defective work (80 per cent of $400.00)	320.00	
	Heat (33 per cent of $270.00)	89.00	
	Light (30 per cent of $200.00)	60.00	
	Power (6 per cent of $600.00)	36.00	
	General expense (50 per cent of $2400.00)	1200.00	
	Total		1750.00
	Total molding burden		$ 4,460.50

Here again the burden is distributed on the basis of productive labor hours. Assuming that there are forty men working a total of 8000 hours per month and that we are

basing the burden on 80 per cent of this figure, we get 6400 hours, which divided into $4460.50 gives a burden rate of 70c per hour.

SANDBLASTING COST

Labor		Monthly	
400	Foreman (20 per cent of $225.00)	$ 45.00	
401	Sand blasters (2 men at 65c per hour)	292.50	
402	Helpers (2 men at 50c per hour)	225.00	
403	Removing sand (general labor charge)	50.00	
	Total		$ 612.50
Supplies			
420	Sand (1 ton per day)	112.50	
421	Hose (12 feet per month)	36.00	
422	Helmets (1/6 per month)	4.00	
423	Goggles	1.50	
424	Connections	10.00	
425	Nozzles	6.00	
	Total		170.00
Apportioned Expenses			
	Compressed air (25 per cent of $450.00)	112.50	
	Heat (5 per cent of $270.00)	13.50	
	Light (6 per cent of $200.00)	12.00	
	Power (5 per cent of $600.00)	30.00	
	General expense (6 per cent of $2400.00)	144.00	
	Total		312.00
	Total sandblasting cost		$ 1,094.50

It may be noted that the entire sandblasting cost is treated as an indirect expense. The reason for this is that it is practically impossible to charge sandblasting direct. As the amount of sandblasting that must be done depends on the area exposed, there is a direct relation between sandblasting and molding. The sandblasting cost therefore is distributed on the basis of productive molding hours. That means that we must divide $1094.50 by 6400 which gives a sandblasting cost of 2c per molding hour.

CLEANING

Labor		Monthly	
500	Foreman (80 per cent of $225.00)	$ 180.00	
501	Cleaners (2 men at 40c per hour on tumblers and emery wheels)	180.00	
502	Chippers (4 men at 45c per hour)	405.00	
503	Grinders (2 men at 45c per hour)	202.50	
	Total		967.50
Supplies			
520	Files	80.00	
521	Chisels	35.00	
522	Emery wheels	50.00	
523	Small tools	3.00	
524	Rubbing stones	30.00	
	Total		198.00
Apportioned Expenses			
	Heat (6 per cent of $270.00)	16.20	
	Light (8 per cent of $200.00)	16.00	
	Power (5 per cent of $600.00)	30.00	
	General expense (5 per cent of $2400.00)	120.00	
	Total		182.20
	Total cleaning cost		$ 1,347.70

This department is also charged on the basis of molding productive hours, thus $644.85 divided by 6400 gives the rate of 21c per molding hour.

REPAIRING

Labor and Supplies		Monthly	
551	Foreman (225 hours at $1.00)	$ 225.00	
552	Labor (3 men at 45c per hour)	303.75	
561	Supplies (files, drills, chisels, copper wire, etc.)	40.00	
	Total		568.75
Apportioned Expenses			
	Heat (3 per cent of $270.00)	8.10	
	Light (4 per cent of $200.00)	8.00	
	Power (2 per cent of $600.00)	12.00	
	General expense (2 per cent of $2400.00)	48.00	
	Total		76.10
	Total repairing burden		$ 644.85

This department is also charged on the basis of molding productive hours, thus $644.85 divided by 5400 gives the rate of 10c per molding hour.

JAPANNING

Labor		Monthly	
601	Foreman	$ 225.00	
602	Filling and japanning	300.00	
603	Sanding	200.00	
604	Rubbing	200.00	
605	Varnishing	150.00	
606	Skilled labor	50.00	
607	Unloading, trucking and cranes	65.00	
608	Oven tender	100.00	
	Total		1290.00
Supplies			
651	Fillers	200.00	
652	Japan	100.00	
653	Sandpaper	100.00	
654	Rubbing stone	2.00	
655	Varnish	50.00	
656	Coal	200.00	
657	Gas	200.00	
658	Wood	5.00	
659	Kerosene	5.00	
660	Felt blocks	5.00	
661	Miscellaneous	5.00	
	Total		872.00
Apportioned Expenses			
	Compressed air (45 per cent of $450.00)	225.00	
	Heat (30 per cent of $270.00)	81.00	
	Light (30 per cent of $200.00)	60.00	
	Power (2 per cent of $600.00)	120.00	
	General expense (28½ per cent of $2400.00)	684.00	
	Total		1170.00
	Total japanning burden		$ 3,332.00

Japanning is a process, therefore it is assumed that the products that will go through this process will be of uniform character. In that case the japanning department should be made a production center and all the expenses incurred in this including labor and supplies will be totaled and divided by the number of units that pass through the department in one month to determine the cost per unit. However, if a variety of products go through in insufficient quantity to permit setting up a special rate for each one it will be necessary to base this cost on productive labor in the molding department, as in the case of sandblasting, cleaning and repairing. Thus, japanning will cost $3332.00 divided by 6400, giving a burden rate of 52c per molding hour.

COMPRESSION COSTS

Labor and Supplies		Monthly
701	Engine oil	$ 50.00
702	Compressor oil	52.00
703	Packing	7.00
704	Cylinder oil	16.50
705	Grease	17.50
706	Waste	7.00
	Total	150.00

Labor furnished by maintenance gang whose time is charged to general expense.

Apportioned Expense

Power (50 per cent of $600.00)	300.00	300.00
Total compression expense		$ 450.00

Compression expense is distributed on the basis of the number of cubic feet used for the various pipes.

Distribution of Compression Expense

	Cubic feet	Per cent	
Melting department	24	2	$ 9.00
Molding department	120	10	45.00
Sandblasting	300	25	112.50
Japanning	540	45	202.50
General expense	216	18	81.00
Total	1200	100	$450.00

The heat expense consists of the cost of coal alone. The other expenses in connection with this item, namely maintenance, operation cost, and supplies are cared for through the general expense account. The work of the men who tend the boilers is identified with so many of the departments that it is impossible to affect an equitable distribution of their wages unless the plant is quite large. The coal cost is based on an estimate of 300 tons per annum at the rate of $10.00 per ton making a total cost of $3000.00. This is reduced to a monthly charge of $250.00 and is distributed to each department on the basis of square feet of floor space occupied.

Distribution of Heat Expense

	Square feet	Per cent	
Melting department	600	2	$ 5.00
Coremaking department	1200	4	10.00
Molding department	15,000	50	125.00
Sandblasting	1500	5	12.50
Cleaning	1500	5	12.50
Repairing	1500	5	12.50
Japanning	6000	20	50.00
General expense	270	9	22.50
Total area heated	30,000	100	$250.00

Light expense is based on the average monthly cost and is apportioned between light and power on the basis of amperes used. The total electric current expense is $800.00 per month of which $200.00 is charged to light. Distribution of light expense in the department is reduced to the wattage of each department. For example, if the sandblasting room uses ten 75-watt lamps the total wattage for the sandblasting room is 750 watts. This system of measuring light expense and apportioning it to each department is used wherever there are no meters which give accurate measurement of the actual current consumed.

Distribution of Light Expense

	Watts	Per cent	
Core room	330	3	$ 6.00
Molding department	3300	30	60.00
Sandblasting	660	6	12.00
Cleaning	880	8	16.00
Repairing	440	4	8.00
Japanning	3300	30	60.00
General expense	2090	19	38.00
Total	11,000	100	$200.00

Power costs are arrived at in connection with the cost for current whether the current is generated in a plant at the foundry or whether it is purchased from the outside. In the hypothetical case which has been set up here the power cost averages $600.00 per month. It is distributed to each department on the basis of the horsepower of each motor used in that department times the number of hours that the motor is in use.

Distribution of Power Expense

	Per Cent	
Melting	4	$ 24.00
Molding	6	36.00
Sandblasting	5	30.00
Cleaning	5	30.00
Repairing	2	12.00
Japanning	20	120.00
Compression	42	300.00
General expense	8	48.00
Total	100	$ 600.00

General expense is determined on an annual basis and then subdivided by 12 to arrive at the monthly rate which is apportioned to the various departments on the basis of labor hours. The list of the general expenses and their account numbers are given below.

GENERAL EXPENSE

1001	Salary of superintendents	$ 4000.00
1002	Clerical salaries	1200.00
1003	General labor	3199.60
1004	General repairmen	5000.00
1005	Watchmen	1300.00
1006	Truck maintenance	800.00
1007	Maintenance of building	200.00
1008	Maintenance of machinery and equipment	1500.00
1009	Depreciation on building	1500.00
1010	Depreciation of machinery and equipment	3170.00
1011	Depreciation on office equipment	200.00
1012	Taxes	1500.00
1013	Insurance	1000.00
1014	Miscellaneous expense	1000.00
	Total	$ 25,569.60

Apportioned Expense

	Per Cent	
Compressed air	18	$ 972.00
Heat	6	194.40
Light	19	456.00
Power	8	648.00
Defective work	20	960.00
Total		3,230.40
Total general expense		$ 28,800.00

$28,800.00 divided by 12 gives a monthly general expense charge of $2400.00.

Distribution of General Expense

Melting	3½	$ 84.00
Core making	5	120.00
Molding	50	1200.00
Sandblasting	6	144.00

Cleaning	5	120.00
Repairing	2	48.00
Japanning	28½	684.00
Total	100	$ 2400.00

ADMINISTRATIVE AND SELLING EXPENSE

Administrative and selling expense is composed of all those items of expense which are necessary to the operation of the business, but which have no immediate connection with the actual production, and therefore with the cost of production. However, these expenses vary in almost direct proportion to the volume of the business. It is therefore found justifiable to distribute office and selling expenses to the individual jobs on the basis of a flat percentage of the foundry cost of these expenses and their account numbers are as follows:

1101 Executive salaries	$ 5000.00
1102 Sales cost	5000.00
1103 Clerical salaries	5000.00
1104 Stationery, printing and postage	1200.00
1105 Office expenses	350.00
1106 Telephone and telegraph	1000.00
1107 Legal expenses	500.00
1108 Professional fees	500.00
1109 Subscriptions	300.00
1110 Fire Insurance	1600.00
1111 Interest on loans	1000.00
1112 Discount on sales	3000.00
1113 Bad debts	3000.00
1114 Miscellaneous expenses	1000.00
Total	7000.00
Grand total	$ 28,450.00

How and Why in Brass Founding

By Charles Vickers

Cleaning Brass Castings

We would greatly appreciate suggestion as to the best method for cleaning small brass castings, weighing from ½ to 1 pound each. We do not have a sand blast, and we thought of using an oblique tumbling barrel. We want to learn if this is advisable and what to put in the barrel with the castings to clean and brighten them?

Oblique tumbling barrels frequently are used for cleaning small brass castings. If the barrel is to be run dry, the skimmings from the hearth can be put in with the castings with the effect of cleaning and brightening them, also making it easier to separate the dirt from the skimmings.

A horizontal wood-lined tumbling barrel that tumbles wet and has a settling trough to retain the fine brass from the skimmings does good work in cleaning small brass castings, when the barrel is packed full of castings mixed with skimmings and is then rotated until the contents are polished.

Such a barrel is not expensive to install and will not only clean the castings, but is a great aid in salvaging brass from the skimmings.

Metal Sticks to Mold

We experience difficulty with our ingot metal sticking to the cast iron molds, and find it necessary to use a hammer on each one to loosen the brass. Can you advise us of a preparation that can be used on the ingot molds to prevent this trouble?

When new ingot molds are required it would be advisable to have the pattern changed giving the sides of the ingot more slope. Also, if there are any notches in the cast ingot of brass the ridges inside the mold that produce these notches should be made as rounding as possible and spread out at the base, so they will not crack and make crevices into which the metal can run and thus get anchored.

To prevent sticking of the brass, coat the molds with a cream made by mixing plumbago with kerosene. The oil will not cause the metal to fly when it is poured and after the ingots have been used a few times they will come out bright and clean. The molds will require coating at intervals of several days.

Uses Too Much Lead in Brass Mixtures

We are making small brass castings weighing about half a pound each, using a mixture of copper, 65 per cent; zinc, 25 per cent; lead 8 per cent, and tin, 2 per cent. The castings are thin and fancy in design, and the metal must be poured extremely hot to run them. We are using a fine grade of sand, but the castings come out rough. Can you tell us how to get smooth castings?

The reason the castings come out rough is that the mixture contains too much lead by several per cent for a yellow brass for such purposes. The following mixture will produce better castings;

CLEAN RUNNING YELLOW BRASS

	Per cent
Copper	70.00
Zinc	26.00
Lead	2.00
Tin	2.00

The following cheap mixture will run the castings. It must be poured hot enough to flare strongly.

CHEAP YELLOW BRASS

	Per cent
Copper	58.25
Zinc	40.00
Lead	1.00
Tin	0.50
Aluminum	0.25

Add the aluminum to the copper after it is melted.

Making Magnesium Alloys

We understand that an alloy of 10 per cent magnesium with 90 per cent copper is being used in brass foundries. We have had no experience with magnesium, and would like to learn what it is, and how the alloy with copper is made.

Magnesium is a metal like aluminum, but is even lighter in weight than aluminum, but it is not used to the extent that aluminum is because it is not so easy to manipulate in foundry work, owing to the fact that it ignites and burns. Therefore, it requires great care and special knowledge to make castings of magnesium, and few brass founders attempt it. As a deoxidizer it is used in alloys high in nickel, like monel metal, and also to some extent in bronzes. The alloy of 10 per cent magnesium; 90 per cent copper is convenient when magnesium is to be added in small amounts to copper alloys, and is used extensively.

It is not difficult to make this alloy.

The requisite amount of copper is melted under a covering of magnesia (the white powder bought at drug stores) with which a little borax is mixed to hold it together. The pieces of magnesium are tossed onto the top of the copper where they lie on the flux until heated, and then are stirred into the copper. The magnesium will hiss a little like zinc, but that is all, and there will be little loss. It is not necessary to use phosphorizers when making such alloys.

Flour Leaves Clean Skin on Brass Castings

What kind of facing material can we dust on our molds to produce a nice bright skin on our brass castings? At present we employ plumbago and the castings present a dark skin. We make trolley wheels and other castings of a somewhat similar character which are not machined all over and our castings look so black they suffer in comparison with castings made by other manufacturers. Would you advise pickling the castings or can you suggest a more suitable facing than graphite?

Pickling brass castings is a messy job, it is also expensive and time consuming and unless handled by an experienced man the results are not satisfactory. A red brass free from impurities, especially iron, is the first requisite to secure bright, orange colored castings. For this purpose virgin metals may be used with confidence. Trolley wheels are made from a copper-tin alloy in which the tin amounts to from 6 to 8 per cent. Unless an undue amount of phosphorus is employed the castings should present a bright and pleasing appearance. Plumbago facing is not suitable for molds for brass castings. It is only employed where the castings are quite heavy. On green sand molds it is applied with a camel's hair brush and on dry sand and skin dried molds it is applied in the form of a wash made by mixing plumbago with molasses water. The most satisfactory facing for brass castings and one that is used the world over, is flour. Not pease meal or rye, but wheat flour. Where a particularly nice color is wanted two coats of flour are applied to the face of the mold. The flour is dusted on through a muslin bag and the superfluous material is blown off with a bellows or air hose. It may be necessary to employ a lifter to remove the flour where it collects in the corners.

Rigging Required To Make Aluminum Kettles

We wish to manufacture cast aluminum tea kettles and would like you to give us all the information you may have on this subject, going into detail as to how the job should be rigged up; the pattern equipment, method of gating required to ensure proper production of good castings.

The most satisfactory way of getting into this line of work line will be to first obtain the services of a man expert in the art of casting aluminum utensils, and this simply is a question of compensation. The situation calls for the exercise of considerable ingenuity in devising follow boards, patterns, flasks and other equipment. Briefly it may be stated that the kettles usually are cast bottom up. They are gated on top of the bottom, following stove plate practise in this respect. The thickness of the metal is an important factor because if under ⅛-inch, the molds will have to be poured so hot, the losses will be high, and offset many times a little more weight of aluminum. A finely finished split metal pattern should be used. The bottom half of the kettle is rammed up first on a follow board and rolled over; this is the cope. The drag is set on, rammed, lifted off, the drag half of the pattern is removed. The drag is replaced and the entire mold is rolled over. Then the cope is lifted off and the cope half of the pattern removed, after which the cope is returned to place.

Aluminum flasks that closely follow the shape of the kettle are employed. The inside of the kettle is made of green sand rammed at the same time as the drag. An ordinary jobbing molder will find this work difficult to handle; but a molder accustomed to making hollow ware in cast iron, will experience no difficulty in turning out satisfactory aluminum kettles. An experienced hollow ware molder with the help of a good patternmaker will be able to design and assemble the proper equipment in the event that it is not possible to obtain the services of an expert in making aluminum castings of this character.

Lead Sweats Through Skin and Forms Scale

Some of our small brass castings have a dark scale on the surface even after they have been sand blasted and dipped in a nitric acid solution. We are using the following alloy: copper (scrap wire) 85 pounds; lead, 5 pounds; tin, 2.5 pounds; and zinc 12.5 pounds. We are sending a sample casting for inspection and will appreciate your comments.

The dark scale is a veneer of lead hardened by the other constituents of the alloy which creeps to the surface of the castings. Although this veneer is very thin it is much thicker than the discoloration produced by oxidation, and that is why it cannot be removed by either sand blast or acids.

The difficulty *may* be overcome by using a flux on the metal as it is melting—one that tends to *hold in* the lead. For example, about 1 per cent of a mixture of 90 per cent plaster of Paris and 10 per cent soda ash. The most satisfactory way to overcome this trouble is to change the alloy. The proportions of zinc and lead in the given alloy are not adjusted to produce a pretty-colored casting. When zinc is too high in a leaded alloy some of the latter is left free, gets out and shows on the surface of the casting. In percentages your mixture is as follows; copper, 80.95 per cent; lead, 4.76 per cent; tin, 2.38 per cent; zinc 11.90 per cent

A somewhat similar alloy, but one that runs free of the lead sweat is the following; copper, 83 per cent; zinc 11 per cent; lead 4 per cent, and tin 2 per cent. Should this alloy be considered a little too yellow, the following alloy shows a fine gun metal color when machined, it is easy to machine and produce clean good-colored castings. The alloy is; copper, 83 per cent; zinc, 5 per cent; lead, 10 per cent; tin, 2 per cent. The use of scrap copper will not affect the lead sweat.

Nickel Alloy for Valves

We want to cast valves of a nickel alloy to match benedict nickel tubing, and the alloy must stand water pressures. We have had much trouble in getting such an alloy.

The production of nickel alloy castings that will withstand pressure requires much careful study and attention to details, from the melting of the metal to the construction of the molds. A better melting ratio of metal to castings produced than 2 to 1 should not be expected as it is not economical to be too thrifty with the melting in the case of such alloys. The following alloy is a good one to experiment with, as due to its high lead content it is not likely to leak.

NICKEL ALLOY FOR CASTINGS

	Per cent
Copper	53
Nickel	15
Zinc	20
Lead	10
Tin	2

It is advisable to purchase ingots of an alloy of 50 per cent nickel and 50 per cent copper, and melt 30 per cent of this half and half alloy with 38 per cent copper. The zinc, lead and tin then can be added. Use charcoal as a covering on the metal, and an alloy of nickel and magnesium for a deoxidizer. An alloy of zinc and nickel also can be obtained should this be preferred to the alloy of 50-50 copper nickel.

Graphite Form in Gray Iron-I

First or Primary Graphite Influenced by Occurrence of the Structural Form of Agraphitic or Amorphous Carbon—Micrographs Indicate Relation of the Primary Forms to the Graphite Flakes

BY J. W. BOLTON

THE amount and distribution of graphite flakes in gray iron is one of the more important of the factors governing the physical properties of gray iron. Comparatively little is known about graphitization in commercial gray irons, at least from the viewpoint of the practical foundryman. Besides, little of what is known is utilized by the average foundry. It is an object of this paper to bring home some of the existing knowledge to foundry problems, as well as to give an exposition of some of the work on graphitization conducted at the laboratory of the Niles Tool Works Co., Hamilton, O.

Every foundryman knows that analysis is not the only factor in producing a fine close-grained, strong, easily machinable iron. The structure itself is what produces the strength or weakness; just as in steel. From the viewpoint of the man who makes the casting a lot more knowledge about structure is needed before we can sit back and say this or that will make the best casting. To be sure, much is known on this subject and some foundries apply this existing knowledge to the benefit of their finances. The practical man is interested in any developments which can be used profitably.

While analysis is valuable and even indispensable, experience shows that it is not the whole thing. Other factors enter into the quality of the iron. For example, out of three mixes used by the Niles Tool Works Co., and one made by the Black & Clawson Co. out of the daily routine from July

The author is chemical engineer, the Niles Tool Works Co., Hamilton, O. The article was submitted for publication Dec. 7, 1922.

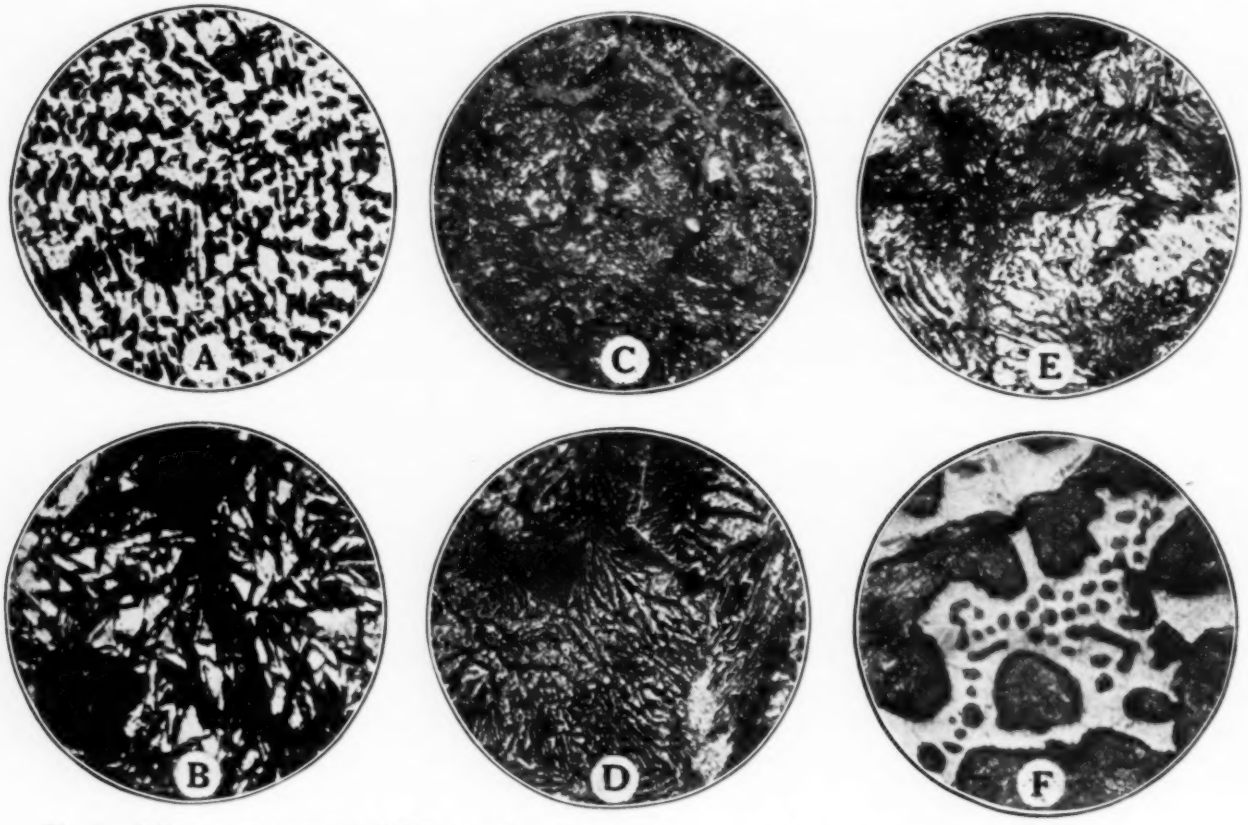


Fig. 1.—Influence of potential distribution of carbon in white iron on the formation of graphite. The micrographs show some striking distributions of graphite which indicate its probable genesis.

A shows striations in graphite resembling some cellular eutectic distributions. The present article points out how this graphitization has been caused by decomposition of cementite and other changes, and is not necessarily influenced by any stresses. Unetched; x 50 dia.

B shows a cementite rich area in a mottled cast iron. Note the resemblance of distribution of cementite (white) to the distribution of graphite shown in A. Etched with picric acid; x 125 dia.

C is from a slightly hypereutectoid iron. Note that distribution of graphite and cementite is the same in portion of striation shown. This juxtaposition (which is shown more clearly under the microscope than on the picture) is practical proof that the striated graphite was a result of graphitization of the carbon of the cementite structure with but little subsequent grain growth and movement. Etched with picric acid, then slightly repolished; in x 100 dia.

D illustrates the same phenomenon shown in C; treatment and magnification the same.

E—Clustering of graphite flakes found on the "skin" of some castings. Unetched; x 65 dia.

BY APPLYING the results of research to practical foundry work the author has produced definite facts regarding the influence of certain forms of graphite on gray iron. He offers proof that the forms of combined carbon determine the first arrangement of graphite flakes. He also distinguishes between the two forms—according to origin—of graphite flakes and names these forms "primary" *and* "secondary." *The articles discuss only the effects of the flake formation, but this is carried into the practical field and so presented that the foundryman not deeply initiated in the science of metallography may understand the author's reasonings and conclusions.*

to November all test bar results were picked. Each result was the average from an analysis of two bars poured at the same time, running over 4500 pounds transverse strength on the standard arbitration test bar. The results showed silicons 1.07 to 1.71 per cent, manganese 0.39 to 0.61 per cent, sulphur 0.09 to 0.134 per cent, total carbons 3.07 to 3.56 per cent, and phosphorus 0.27 to 0.66 per cent. While these variations did not occur in the same mixture, they are great enough to show, when the high strength of all the bars is considered, that the melting conditions, the grades of iron and scrap, the pouring temperature, the amount of air and many other factors may be as important, or more important, than analysis.

Many writers have pointed out that high combined carbon, low total carbon, low silicon and other factors generally producing greater strength do not always do so. We must know more of that which lies back of analysis, of pouring temperature, of section size. These factors influence the structure. The structures have to be ferreted out, their significance determined, then the conditions which produce them catalogued. That is a big order. However, analysis must be continued. Test bars are not the casting. For example, a 1.70 per cent silicon iron showing 5000 pounds transverse strength would be inferior to one with 1.25 per cent silicon and 3800 pounds tensile strength, both irons being used in heavy sections. But while using analysis, is should be remembered that the ultimate solution lies in knowing all about changes of structure.

These structure changes involve not only the changes in amounts of graphite, pearlite, steadite, cementite, and ferrite, but also the little known changes involving particles of almost molecular dimension. We refer to

F shows a form of secondary graphitization. This sample was heated to 1800 *degrees Fahr. for 2 minutes and quenched in oil. Unetched; x* 125 *dia.*

G shows bunched graphite at a higher magnification. Unetched; 300 *dia.*

H, a small nozzle casting, was pulled out of the sand while red hot. On polishing, a cross section showed this remarkable arrangement of graphite. These graphite forms bear some relation to prima austentite in size and in general outline. The dendritic cores are free from graphite, (i. e. low in carbon), a condition resembling that which sometimes obtains in the selective crystallization of prima austenite; that is, the nucleus of prima austenite is comparatively low in carbon. On cooling and growth the additions to the nuclear crystal are progressively richer in carbon, and, unless diffusion is complete, the shell will be richer in carbon than the matrix. Unetched; x 125 *dia.*

I and J show portions of this structure as seen at higher magnification. Unetched; x 325 *dia.*

K shows occurrence of ledeburite in cementitic area. Note resemblance of this structure to that shown in F. Etched with picric acid; x 100 *dia.*

L shows graphite structure which existed in sample F before heat treament. Unetched; x 100 *dia.*

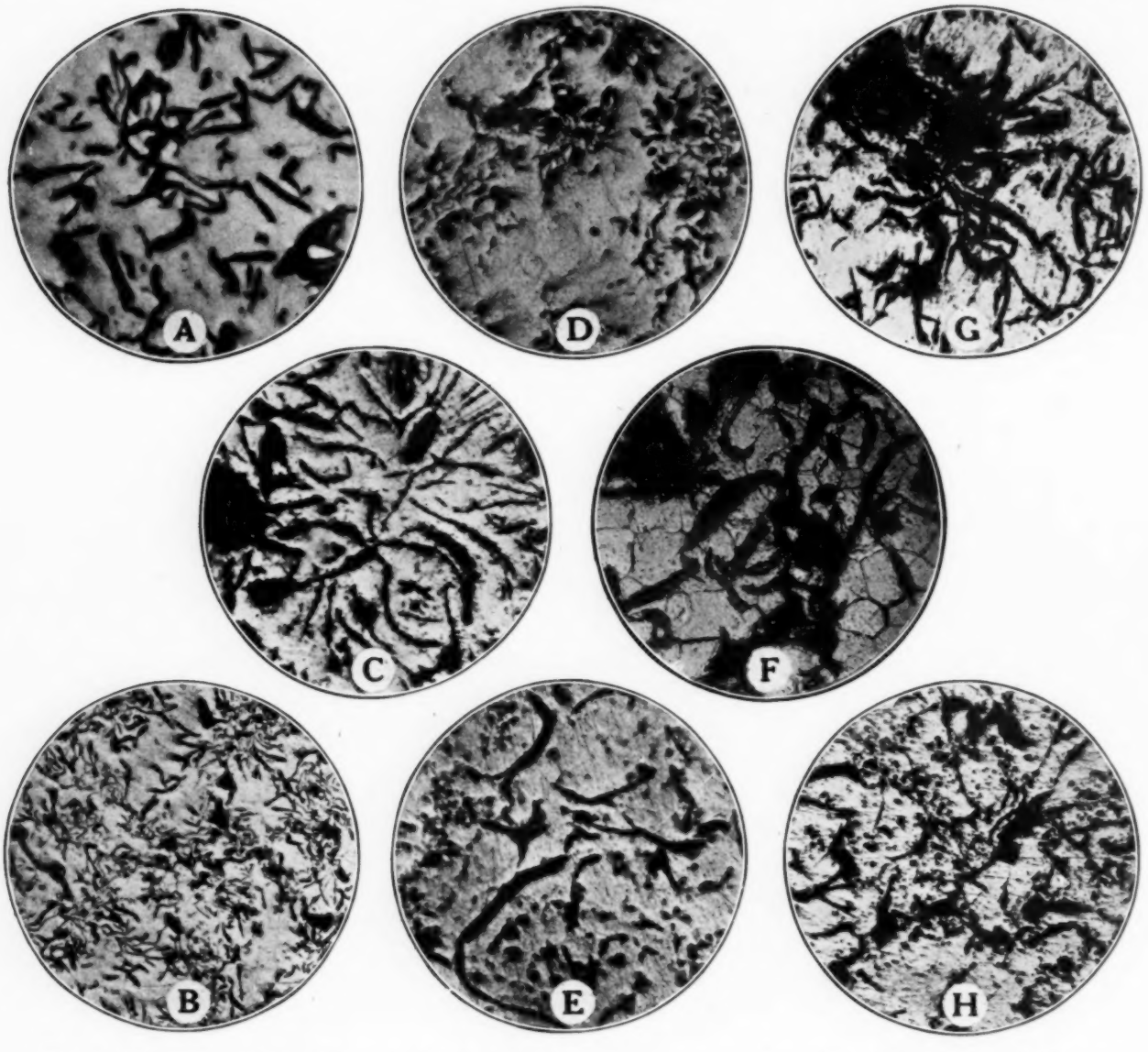


Fig. 2—These illustrations show a number of the more common forms of graphite flakes. The peculiar groupings and whorls suggest the need of research to the careful investigator.

A is what might be called a normal distribution of graphite flakes; that is, the flakes are medium sized and there is no pronounced grouping. Unetched; x 100 *dia.*

B shows marked grouping of graphite flakes in whorls, first illustrated by the author in Fig. 13, *p.* 110, THE FOUNDRY *Feb.* 1, 1922. *This condition seems to cause a rather weak iron. Unetched; x* 65 *dia.*

C—From a mixture containing about 30 *per cent charcoal iron. Unetched; x* 100 *dia.*

D shows another grouping of graphite flakes. Note the rounded particles as opposed to the long, coarse flakes of B; 20 *per cent charcoal iron in mixture; silicon* 1.34 *per cent; total carbon* 3.79 *per cent; strength low. Unetched; x* 100 *dia.*

E—The graphite flakes occur in curved pencils rather than in comparatwely straight flakes. Unetched; x 65 *dia.*

F—Silicon 1.04 *per cent; total carbon* 3.25 *per cent. This sample was annealed in ashes at* 1600 *degrees Fahr. for* 5 *hours and cooled in furnace. Note black bunches round of temper carbon, the regular graphite flakes (curved and gray) and ferrite (polygonal crystals). This illustration shows the two forms of graphite in cast iron. Etched with picric acid; x* 100 *dia.*

G—An iron showing open grain in some places. There seems to have been local precipitation of graphite in large bunches rather than formation of the long heavy flakes usually associated with open grain. Unetched; x 100 *dia.*

H shows influence of bad melting and high sulphur on graphite flakes. Unetched; x 100 *dia.*

gases in the iron, to actual distribution of silicon, and to other similar phenomena. Foundrymen have plenty of practical evidence of the existence of these latter changes. As an example, a list of analyses of irons, all of which run under the requirement of 3800 pounds transverse, was prepared. Strength tests at this plant are made in duplicate. It was not long before it was noticed that where the strength was low, one bar of the two had been thrown out because of some flaw. The usual type of flaw is the small blowhole. This indicated that the iron was about saturated with gas which lowered the strength of the sound bar. Such examples could be multiplied indefinitely. In the present stage of gray-iron research, a lot is not known about these complex mechanisms, but the next few years may bring the solution.

In a previous article* the writer has

indicated the general structure of graphite flakes, outlined some of the factors of graphite growth, and showed how the general formation and growth of graphite follows the familiar laws of physical chemistry. In this article it is intended to make more clear how the pencil-like graphite flakes are formed from the various forms of carbon which exist in combination or in solution. This work should be of special interest to foundrymen, as it was done on regular commercial irons with the ordinary ranges of silicon and other elements.

At stated in the article referred to, graphite flakes consist largely of graphitic carbon enmeshed in a ferritic network. The flakes also contain sulphides* and occluded gases **. The original nuclei of graphite are augmented by the phenomenon of grain growth, the flakes not remaining in place in their original carbon-rich areas, but slowly agglomerating into fewer and larger flakes. This growth and the related graphitization phenomena of the combined and dissolved carbon may proceed below the A_1 point on the iron-carbon diagram. The final shape and distribution of these graphite flakes have a profound influence on the properties of the castings. We have never seen a high strength iron with coarse graphite flakes, nor a weak, open one with fine, evenly distributed graphite flakes. Knowing how to produce the proper graphite flake structure will be a big step to obtaining the best grade of gray iron.

Since publication of the paper, "Influence of Graphite on Iron,"* there have been published, or have come to the author's attention, a number of valuable articles on graphitization by various workers. A brief account of some of these is incorporated here because the exposition of the influence

*THE FOUNDRY, June 1, 1922.

**Tario Kikuta, in fifty-ninth report of the Iron and Steel institute (Tohoku Imp. university, Japan).

*THE FOUNDRY, June 1, 1922.

*FOUNDRY, June 1, 1922.

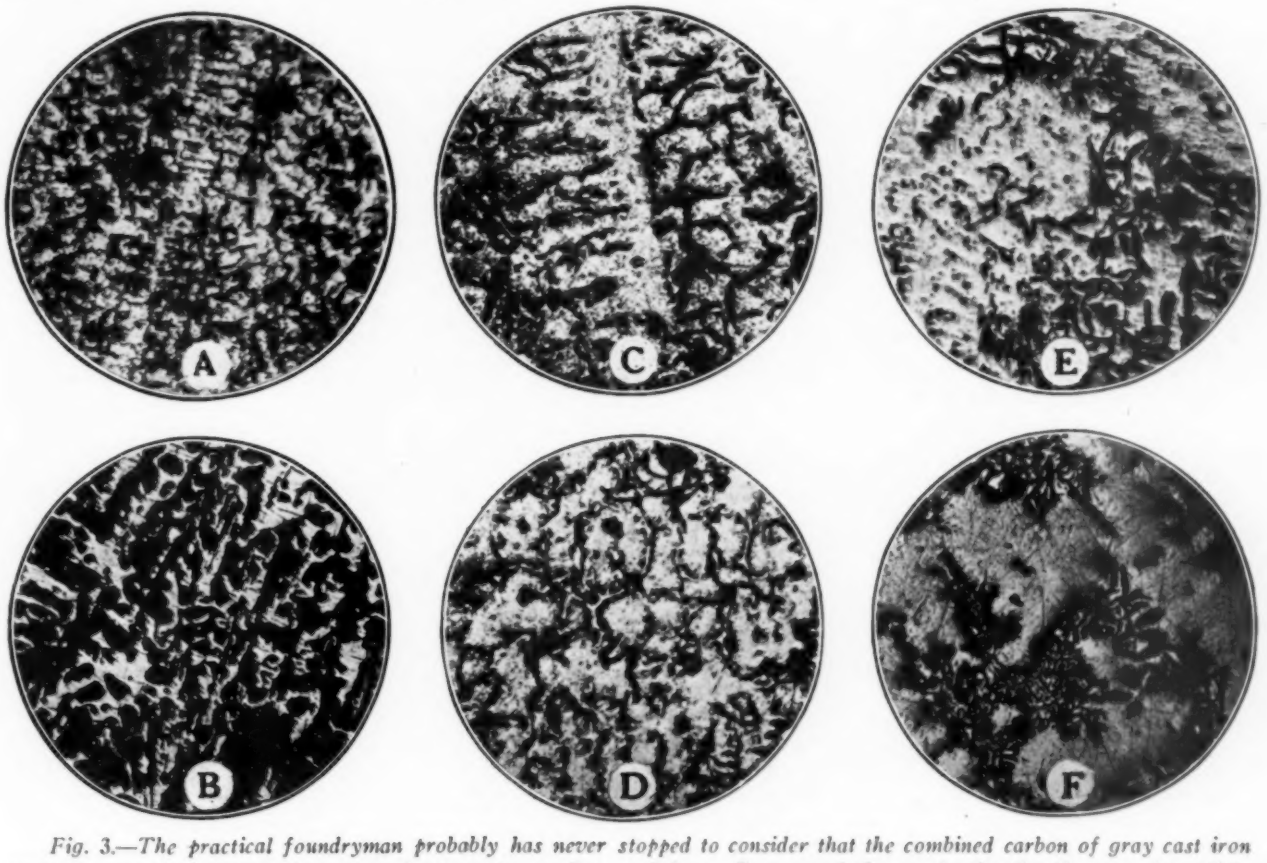


Fig. 3.—The practical foundryman probably has never stopped to consider that the combined carbon of gray cast iron undergoes much the same changes on heat treatment that steel does. Because of changes in the phosphorus and graphite formation it seems unlikely that heat treatment of gray iron will be generally used. Our experience has been that heat-treated iron has about the same strength as the original, less deflection, and is intensely hard.

A—White cast iron; all carbon combined. White portion is cementite and ledeburite; dark is pearlite. Etched with picric acid; x 75 dia.

B—Ordinary gray iron heated quickly to 1800 degrees Fahr., held 2 minutes and quenched in oil. The acicular or needle-like structure is characteristic of martensite. The white background is probably austenitic. The dark rounded spots are probably troostite. Etched with Kourbatoff's reagent for hardened steels; x 1000 dia.

C—Ordinary gray iron heated quickly to 1800 degrees Fahr. and cooled in air. The finely divided structure which is barely resolved at 575 diameters magnification is sorbite, or sorbite just passing into pearlite. Etched with picric acid.

D—The same sample shown in Figs. B and C was held at 1800 degrees Fahr. and cooled in the furnace. The micrograph shows that the combined carbon is now in the pearlitic state, the normal state of combined carbon in gray cast iron under 0.80 or 0.90 per cent combined carbon. Etched with picric acid; x 600 dia.

E—Represents a section of an arbitration test bar which had a transverse strength of 5000 pounds. Close inspection shows small grains of finely laminated pearlite. Etched with picric acid; x 1000 dia.

F shows ledeburite. Ledeburite is the eutectic of cementite and austenite, transformed in cooling to cementite and pearlite. The cementite being hard, was polished in relief. Phosphorus is 0.27 per cent. This section is largely cementitic. Etched with picric acid; x 600 dia.

of pre-existent forms of carbon on the formation of graphite flakes will be more clear in the light of this new knowledge.

A number of workers have put forth double iron-carbon equilibrium diagrams. Without going into any great detail about a subject on which he is only moderately familiar, the author cannot believe that (around the eutectic line) graphite forms directly from solid solution of carbon or from a graphite-austenite eutectic rather than from cementite; unless the formation of this solid solution has been preceded by formation of cementite. Two practical and familiar experiences will illustrate. With more rapid cooling, more cementite and less graphite is formed. If cementite were formed from an iron-graphite mixture, the quicker cooling would show this mixture rather than cementite. It is every day experience that on slow cooling much large graphite is produced at the expense of cementite carbon. Thus graphite is the final form of carbon at ordinary temperatures and cementite carbon the primary. This view of the author does not question the existence of carbon in solid solution in gray iron as free carbon, not cementite. Thus it was pointed out that some carbon must exist in ferrite to allow the phenomenon of grain growth. H. A. Schwartz, H. R. Payne, A. F. Gorton and M. M. Austin*, have shown that there exists a solid solution of the stable system (iron-carbon) as well as the solid solution austenite (iron-cementite). This solid solution of iron and dissolved carbon they named *boydenite*. The solubility curve of carbon in boydenite has been determined. They explain graphitization as taking place by supersaturation of boydenite. The definite determination of the existence of this intermediate stage (boydenite) makes much clearer our conceptions of the mechanism of graphitization.

Pressure Modifies Results

In considering the formation of graphite flakes the temperature, variations in size of flakes, and the presence of other elements have been mentioned. Another factor—pressure—has not received sufficient recognition. It is the practice in most foundries to put faces to be machined, like those on lathe beds, in the drag. This not only produces a cleaner surface for machining but some claim it tends to close the grain. This, insofar as we know, has not been definitely proved. However, several writers have attributed the phenomenon known as internal chill* to pressure. Their argument is that carbon is retained in the cementitic condition when under high pressure because formation of graphite flakes involves an expansion of the metal. Foundrymen will recall that gray iron shrinks much less than white iron. Can we make closer grained iron by increasing the ferrostatic pressure?

Annealing and tensile tests of gray iron castings have been made by J. F. Harper and R. S. MacPherran.* On the type of irons examined, one hour's annealing at 1150 degrees Fahr. produced little change. A lowering of the physical properties accompanied by some enlargement of graphite flakes and decrease in combined carbon followed annealing at 1250 degrees Fahr. At 1400 degrees Fahr. the change is complete. Somewhat above 1400 degrees Fahr. the graphite goes back into solution. Continued annealing at 1150 degrees Fahr. caused material loss of strength. It would seem from the data submitted that the results obtained were largely due to changes in graphitic and combined carbons. It would be interesting to study the influence of these treatments on phosphorus-rich structures. At somewhat higher temperatures a decided change occurs in steadite structures. This may have considerable to do with the properties of high-phosphorus metal. It may be noted in passing that there is resolution of graphite in hypoeutectoid irons on heating.

Due to Graphitic Carbon

A. W. F. Green* calls attention to black fractures occurring occasionally in annealed carbon tool steel. It has been shown that this case of black fracture is due to graphitic carbon. The evidence showed that there were other influences beside time, temperature, and chemical composition which contributed to the formation of graphite. It is indeed interesting to men with the practical foundry viewpoint to see these unusual tendencies toward graphitization because study of these phenomena may enable them to control the properties of the metal more closely.

Graphite flakes in cast iron result from the freeing of nongraphitic (agraphitic) carbon from the iron. This carbon may have existed in one of two general forms; in chemical combination, or in solution. For a number of years all the agraphitic carbon was generally thought to exist in combination. In reality, it exists both in combination and solution. This has been proved in various ways and the fact follows the general laws of physical chemistry.

Structural Forms Vary

Agraphitic carbon may exist in a number of structural forms. The principal ones are primary cementite, prima austenite, eutectic cementite, and austenite (ledeburite), proeutectic cementite, proeutectic austenite, cementite separating from supersaturated austenite, boydenite, and pearlite. These structural forms vary in carbon content and in distribution. This suggests that they should have various tendencies toward graphitization. While this has been recognized in case of hypereutectic irons, there has been little proof advanced to show what these tendencies are in the commercial hypoeutectic metals. It is a purpose of this article to show that the *first or primary graphitization is influenced profoundly by occurrence of the structural forms of a graphitic carbon.*

Cementite, (Iron carbide, Fe_3C) exists either as the free carbide or in solution. The compound cementite is often described as metastable; that is, it is stable at room temperatures only because cooling has prevented its decomposition into carbon (graphite) and iron (ferrite).

This decomposition proceeds according to the reaction

Cementite = Carbon + Ferrite + Energy

It is a general law of chemistry that reactions which give off heat, or other energy (i.e., are exothermic), proceed toward completion. This finely divided (atomic) carbon is dissolved in the surrounding ferrite, forming the solid solution called boydenite.

The solubility of carbon in boydenite is limited so that shortly graphite carbon begins to separate. This action of carbon in boydenite is similar to that of cementite in austenite. The viscosity of the red hot metal is high, the metal being more or less rigid. Therefore, the graphite is held close to where it started to precipitate if the metal is cooled rapidly. Slow cooling gives a chance for more movement, allowing graphite growth to occur.

It has been known for a long time that graphite flakes separate in the form of kish above the solidification point from irons with enough car-

*Professor Heike, in *Stahl und Eisen*, March 2, 1922, and Richard Moldenke in *Principles of Iron Founding*.

*J. F. Harper and R. S. MacPherran, "Annealing Gray Cast Iron," Vol. 30, *Transactions*, American Foundrymen's association, and THE FOUNDRY, March 1, 1922.

*Transactions of the American Institute of Mining and Metallurgical Engineers, 1922.

*Chemical & Metallurgical Engineering, Aug. 9, 1922, p. 265.

THE FOUNDRY DATA SHEET, AUGUST 15, 1923
[Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note book form.

ANALYSIS OF CUPOLA SLAGS

By J. W. Bolton

Cupola slags consist mainly of iron oxide, FeO; of aluminum oxide, Al_2O_3; of lime, CaO; of magnesia, MgO; and of silica, SiO_2. Silica, SiO_2, is acid, while FeO, CaO, and MgO are basic. The acid and basic oxides unite to form compounds, such as the silicates, somewhat according to the reaction:

$$CaO + SiO_2 = CaSiO_3$$
lime silica calcium silicate

The major part of the lime and magnesia comes from the limestone used as a flux. The bulk of the other oxides comes from the coke ash, the dirt on the iron, and the lining. In addition to the above oxides, sulphur is an important constituent. There is a great variety of other substances which may be found in slags, but as these are of little commercial importance they will not be considered here.

The complete and exact analysis of cupola slag is a complicated and tedious procedure and the work involved is not ordinarily worth while for commercial purposes. The following method is designed for the chemist who has an occasional slag example on which he wants to get the maximum practical results with the minimum expense. This method will be found to give results well within the accuracy necessary to commercial practice and easy to check closely.

Sampling—Slags from different parts of a heat vary considerably. A fairly satisfactory method is to take small samples from the slag spout at regular intervals. This sample is broken and quartered until enough remains to fill a 2-ounce bottle. This is ground to 80 mesh.

Procedure—Two samples are weighed; the first for SiO_2, FeO, MnO, Al_2O_3, CaO, and MgO; the second for sulphur.

Mix 0.5 gram sample with 2½ to 3½ grams sodium carbonate, Na_2CO_3, and about ½ gram sodium nitrate, $NaNO_3$, in a platinum crucible. Fuse mixture for

(*Continued on Data Sheet No.* 490)

ANALYSIS OF CUPOLA SLAGS

(*Continued from Data Sheet No.* 489)

30 minutes. Dissolve fusion in dilute Hcl and evaporate to dryness, avoiding spattering. Add 15 c.c. conc. Hcl and re-evaporate almost to dryness. Add 4 or 5 c.c. more of Hcl, and as soon as iron is dissolved, 200 c.c. of water. Heat just until soluble salts are dissolved and filter off SiO_2. For work accurate to closer than 0.5 per cent it is necessary to re-evaporate filtrate and filter off silica, ignite in a platinum crucible then weigh. Weight of SiO_2 x 200=per cent SiO_2 (silica).

Evaporate filtrate to 25 or 30 c.c. volume, dilute to 150 or 200 c.c. and neutralize with Na_2CO_3. Add 5 or 6 grams excess caustic soda or potash, NaOH or KOH, and heat to boiling. Add 2 or 3 grams Na_2CO_3 and continue boiling for 5 minutes. Allow precipitate to settle. Filter through a coarse texture qualitative paper, washing well with hot water until neutral to litmus. The filtrate contains aluminum. The precipitate contains iron, manganese, calcium, and mangnesium.

Alumina—Acidify filtrate with Hcl, and add a moderate excess of ammonia. Boil gently until smell of ammonia is faint, keeping volume at about 250 c.c. Allow precipitate of alumina $Al(OH)_3$, to settle for a short time. Filter through loose texture quantitative paper, washing *thoroughly* with hot water. Ignite to Al_2O_3 in an alundum or porcleain crucible. Weight of Al_2O_3 x 200=per cent Al_2O_3 (alumina).

Iron Oxide, Manganese Oxide, Magnesia and Lime—Dissolve precipitate in hot dilute nitric acid, (1 to 1). Dilute to 250 c.c. in volumetric flask at room temperature. Pipette off 50 c.c. for manganese determination into a small beaker. Finish as bismuthate method in gray iron (data sheets Nos. 412 and 413, Jan. 1, and 15, 1922) using factor 1.29 to convert per cent manganese to per cent manganese oxide.

(*Continued on Data Sheet No.* 491)

Wilfred Lewis, President
Theo. J. Lewis, Vice Pres.
H. W. Brown, Secretary

THE TABOR MANUFACTURING CO.
6225 TACONY STREET
PHILADELPHIA, PENNA.

May 25, 1923.

Mr. J. D. Pease,
Director Advertising Sales,
THE FOUNDRY,
Cleveland, Ohio.

Dear Mr. Pease:

We have your favor of the 23rd inst, and are very glad indeed to add our endorsement of the advertising value of THE FOUNDRY to the many others that you will without doubt receive.

As "actions speak louder than words" we might point to the fact that while our Molding Machines go only to the foundry industry, THE FOUNDRY is the only medium of advertising of which we make use.

You, therefore, must know that we appreciate the value of the service that you render, for if we did not feel that your esteemed publication covered the entire field and covered it fully and thoroughly, we would be advertising elsewhere in addition to your paper.

With kind regards, we remain

Very truly yours,

THE TABOR MANUFACTURING COMPANY

H. W. Brown

Secretary

bon to form massive cementite; that is, above tht eutectic for hypereutectic irons. Honda & Marakama* present micrographs illustrating this form of graphitization. Cementite is richer in carbon, containing almost 7 per cent, than any other component, excepting the graphite flakes themselves. Primary cementite separates above the eutectic; that is, above approximately 1100 degrees Cent. It is held that the longer period of cooling in the solid form of the massive cementite of high carbon irons gives a chance for more complete graphitization. While this is undoubtedly true, it is also of interest to note that these large straight flakes resemble in size and shape the structure of massive cementite itself.

Forms Large Dentrites

Prima austenite separates above the eutectic line. It forms rather large dendrites. These dendrites, when cooling and growing, become richer in carbon, and if diffusion is not complete are poorer in carbon at their cores than at their centers. Sauveur* has advanced the idea that irons of eutectic composition may be stronger than irons of lower carbon. Also, it is claimed** that the flakes from the carbon of prima austenite may give rise to large graphite flakes. In contradiction to this, Honda & Murakama claim no graphitization until the eutectic is passed.

The author, prior to April, 1922, had noted a number of peculiar graphite flake groupings in various samples. The resemblance of these to various structural forms in white iron is quite marked. The flowery appearance of some molten irons, presumably hypoeutectic, also pointed to the possibility of separation of graphite flakes above the eutectic; that is, graphitization of prima austenite. Figs. 8C, 9C and 10C show a remarkable graphite grouping. The iron was cooled rather slowly above the eutectic, then cooled quickly from a point somewhat below the eutectic. In length, distribution, and general structure these groupings remind one of prima austenite. The freedom of the cores from graphite is also significant.

To sum up, it is well established that massive or primary cementite gives rise to large graphite flakes at a point above the eutectic temperature. Some workers think that prima austenite may act in a somewhat similar fashion. The author calls attention to two phenomena which indicate that prima austenite may have some direct influence on graphite formation. However, the primary graphite forms (forms before any growth) found do not resemble the large heavy flakes due to massive cementite or the coarse large flakes called for by the theories of other workers. It must be noted that these bunchings of fine graphite are so arranged that their growth might give coarse graphite later. Such growth would be in accord with Mr. Sheffield's theory. Since graphitization is a progressive change and the samples used by Honda & Murakama were small, it is quite possible that any small amount of graphite due to prima austenite was overlooked. So much for the forms separating above the eutectic temperature.

Cementite Graphitizes First

Below the eutectic temperature and above the eutectoid the structural forms which interest us are austenite, various cementites, the euctetic ledeburite, and boydenite. Work here would indicate that the cementite graphitizes first as indicated by Figs. 3C and 4C, or at least that the first graphitization takes place close to the original cementite forms. The mechanism of this is possibly as follows: Some of the cementite of the austenite goes out of combination, giving a solid solution of free carbon (boydenite). This solution of carbon is soon saturated and begins to precipitate graphite. The graphite nuclei continue to grow in amount and probably lessen in number. The condition is analagous to crystallization of any ordinary solution. A constant chain of movement occurs; cementite to austenite, austenite to boydenite, and boydenite to graphite.* On the other hand, there may be some graphitization of the cementite without conversion through the other forms. In either case, little graphite movement takes place. Close examination of the illustrations cited show that the orientation of cementite and graphite is the same. If we examine an ordinary white iron, Fig. 2C, a characteristic arrangement of cementite and pearlite (austenite) is noted. On looking at Fig. 1C a remarkable similarity is seen. There are the same long *pine tree* crystals intersecting at the same angles. To recapitulate, white iron has a characteristic arrangement of cementite and pearlite, Fig. 2C. On complete graphitization of the excess cementite, the graphite flakes, Fig. 1C, are observed to bear a close structural resemblance to the first illustration. On examining an iron with only partly graphitized cementite, Figs. 3C and 4C, it may be seen that the cementite and graphite are identical in arrangement. This evidence on cementite and graphite, the author feels, is proof that the *structural forms of agraphitic carbon have a profound influence on the structural arrangement of primary graphite flakes.* Further, we may *define and identify primary* graphite as that *first formed* graphite which bears *a structural resemblance* to forms of a *graphite carbon. Secondary* graphite flakes are those formed by agglomeration growth, or *rearrangement* of primary flakes. The use of these terms, primary and secondary, will simplify the description of micrographic illustrations of graphite flakes in gray iron. It will also convey a more definite idea of general properties of the metal. The great practical significance of the discovery of the influence of agraphitic carbon is treated later.

Thrown Out of Solution

At the eutectic temperature the carbon content of austenite is some 1.9 per cent carbon. On cooling, much of this carbon is thrown out of solution, forming free cementite. It has been suggested that since at low concentrations the elementary metals are salt-like substances, metallic compounds will exhibit salt-like properties in an even more decided manner. Ionization is one of the more characteristic of these salt-like properties. The possibility of ionization of iron carbide in iron would prove an interesting field for speculation.*

The conversion of austenite and related structures is the same in method as the conversion of the proeutectic cementite. We have been unable to find any evidences that austenite loses carbon without taking an equivalent amount from the free cementite until the cementite is exhausted. This is in accord with the logical supposition that the more saturated parts lose carbon first, the temperature and pressure being the same.

During the conversion of austenite into pearlite several transition forms take place. In chronological order, these are austenite, martensite, troostite, sorbite and pearlite. These forms are illustrated in Figs. 2D, 3D and 4D. Considerable doubt exists as

*Graphitization in Iron-Carbon Alloys, synopsis in *Chemical & Metallurgical Engineering*, Jan. 25, 1922.

*Heat Treatment of Iron and Steel.

**Private communication from W. T. Sheffield, chief chemist, Niles-Bement-Pond Co., Plainfield, N. J., June 21, 1922.

*H. A. Schwartz in *Transactions*, American Institute of Mining and Metallurgical Engineers, 1922.

*Chas. A. Kraus, The Constitution of Metallic Substances, *Journal American Chemical society*, 1922, p. 1216.

to the real condition of carbon in these forms. We have no evidence as to just how they graphitize. The existence of these forms illustrates one of the many complex problems encountered in the study of graphitization.

Fig. 6D is a micrograph of ledeburite, the eutectic of cementite and austenite (pearlite). Fig. 11C shows how this ledeburite occurs in cementite rich areas. It is seen that the ledeburite groups do not resemble the regular cementite forms, as they (ledeburite) occur in bunches of cellular structures rather than in lines. Figs. 5C, 6C and 7C represent graphite forms closely resembling the ledeburite structures in size and general outline. Quite naturally, the graphite groups are somewhat larger than the cementite particles. It is evident that there has been local supersaturation of agraphitic carbon. The available evidence indicates that these graphite groups came from pre-existing or even pre-existent ledeburite.

Occur at Grain Boundaries

No micrographic evidence is revealed of particular graphite structures arising from proeutectoid austenite or from pearlite. By the time the metal has graphitized to this extent it is probable that the original structural forms have been made, and their identity subsequently lost because of grain growth. The carbon of this low carbon austenite and of pearlite merely adds to grain growth or enlarges the secondary graphite. The low carbon ferrite surrounding the flakes may be regarded as low carbon boydenite. The graphite flakes occur at the grain boundaries, or perhaps more accurately, the grain boundaries occur at the graphite flakes.

The formation of graphite is determined by distribution of agraphitic carbon and by grain growth. The flake groupings may be classified as primary (directly from agraphitic forms) or secondary (by grain growth). Thus the structure of the metal is often largely determined by its distribution of agraphitic carbon. This structure in turn depends on the total carbon content. By reaching a clear understanding of these relations, the practical foundryman will be able to get better metal control.

The exposition of these changes has followed the sequence of changes on cooling. In the actual work the opposite direction was taken. Grain growth was studied first. Then the striated graphite and long dendritic forms were found. Finally forms resembling prima austenite were isolated. Practical application of knowledge is up to the individual and some of these applications will be indicated here. One of the most disputed questions is that of high and low total carbon. The general opinion is that low total carbon gives the greatest strength. This is in accord with experience here. Diagram 1 is a summation of results on some 300 test bars tested on the same machine by an experienced operator. Because of variations in other factors, the curves shown are made qualitative. It may be noted that the lowest averaged carbon gives the highest strength. Up to a certain point, increase in carbon is accompanied by decrease in strength. However, at a point which corresponds fairly closely with the theoretical eutectic a rise in strength occurs. Beyond the eutectic the strength again drops. The author's interpretation is this: Low carbon, meaning less graphite flakes, means more of the strong matrix. However, as already indicated, it is likely that the eutectic structure is of better distribution than that of the lower carbon metal. This offsets the disadvantage of more graphite. The difficulty in making low carbon iron in the cupola is well known. It may be better in some cases for small castings to try to get higher carbon as recommended by Sheffield and Sauveur. This is a question which must be decided by each foundry individually. As in much of the work here the graphite flakes are secondary, low total carbon is best. If grain growth has no chance, higher carbon may be advantageous. It might even be that small, even sized flakes will not grow so fast as a mixture of large and small.*

The graphite carbon in gray iron may be classed into two general types. Primary graphite flakes are those graphite flakes which are a direct result of graphitization of agraphitic (nongraphite or amorphous) carbon. Secondary graphite flakes are a result of grain growth. Since the primary graphite flakes follow the outlines of other structural forms, control of these latter will help regulate the formation of graphite structure. Thus, in certain cases, rather high total carbon may give a better, stronger iron than lower total carbon.

*Influence of Graphite on Iron, THE FOUNDRY, June 1, 1922.

The American Nickel Corp. has discontinued its Pittsburgh sales office, and moved the entire sales organization to the main office and plant at Clearfield, Pa.

Steel Turret Track Castings

(*Concluded from Page* 648)

Tensile strength, 84,900 pounds per square inch.

Yield point 46,960 pounds per square inch.

Elongation, 25 per cent in 2 inches.

Reduction in area, 38 per cent.

Many castings were obtained in which the physical properties and analysis far exceeded the specifications. The record of one of the best follows:

Carbon, 0.402 per cent.

Manganese, 0.728 per cent.

Silicon, 0.228 per cent.

Phosphorus 0.016 per cent.

Sulphur, 0.021 per cent.

Tensile strength, 96,071 pounds per square inch.

Yield point 40,255 pounds per square inch.

Elongation, 25.5 per cent in 2 inches.

Reduction of area, 39.2 per cent.

Cold bend, 180 degrees.

The track castings were loaded on a car sometimes three or four high and two wide and annealed in an over-fired type oven. Special cast-iron space blocks were placed between the tracks to keep them straight and also to provide a passage for the heat to circulate. Weights were placed on the top tracks to prevent distortion. The oven was raised to a temperature of 1640 degrees Fahr, in 6 or 7 hours, maintained at this temperature for 6 hours and then allowed to cool slowly. The castings were annealed thoroughly and the amount of distortion was neglible. Seven annealed tracks, also the cast-iron spacers referred to are shown in the ilustration Fig. 7.

One of the 62½-degree top castings and a nearly finished bottom castings are shown in Fig. 6. It will be noted that the gap in the bottom track casting is tied together by two 2-inch square bars to prevent distortion. The castings were sandblasted and the gates and risers cut off by an oxyacetylene torch.

Will Build Addition

Construction of a foundry addition costing $200,000 and doubling the present capacity will be started Aug. 1 by the Belle City Malleable Iron Co., Racine, Wis. Only the first half will be erected this year. The building will be 115 x 360 feet, and connect the present foundry with a core and mill building costing $125,000 now under construction. Besides finishing this job early next year the company plans to connect the new annealing building recently completed with the shipping building by erecting a brick and steel bay.

Cheapens Core Sand Mixtures

Experiments Said To Indicate Costs In Shops Making Light Steel Castings Can Be Reduced by Using Heap Sand in Cores—Tensile Testing Machine Determines Strength of Dried Mixtures

BY C. S. KOCH

THE object of this paper is not to cover the entire field of making cores for light steel foundry work, but is rather to give, in a general way, the results of an investigation made at the plant with which the writer is connected, at the instigation of the Electric Steel Founders Research group.

The research was not started for the reason that the cores which the group as a whole were making were not satisfactory, but rather to determine if it were not possible to reduce cost of core mixtures, especially costs by the use in the cores of more heap sand. Other points also were to be considered, such as temperature and time of drying, percentage of moisture in cores, and all other matters pertaining to coremaking which might facilitate output.

In such an investigation, two important measurements were necessary for every mixture tried; namely, the strength of the core and the cost of the mixture. Therefore, a small tensile test machine was developed by which briquets were pulled. These briquets had a breaking section of only ¼ square inch; that is, ½ inch on the side, instead of the more commonly used inch square briquet. The cost was taken care of by figuring the actual cost of 100 pounds of mixed core sand.

Accordingly, a test sheet was made for every mixture tested, and on this sheet was given the tensile strength of the cores, the cost of the mixture as well as much other information regarding methods by which the sand was mixed, time and temperature of baking, and other details, concluding with a statement as to the quality of the resulting cores. The permeability of the cores is not included because in the early months of this investigation repeated tests were made on the permeability of the cores by one of the well known methods of permeability. Results showed that all cores made with the sand and ordinary core binders on the market came well within the practical requirements. It, of course, showed that different sands and different binders gave somewhat different degrees of permeability, but the open sand used by well known foundries is so far within the allowable limits of permeability that we could not even determine what would be the danger point. This, of course, applies to the vast majority of cores. Some cores with small openings, allowing insufficient venting, might prove exceptions.

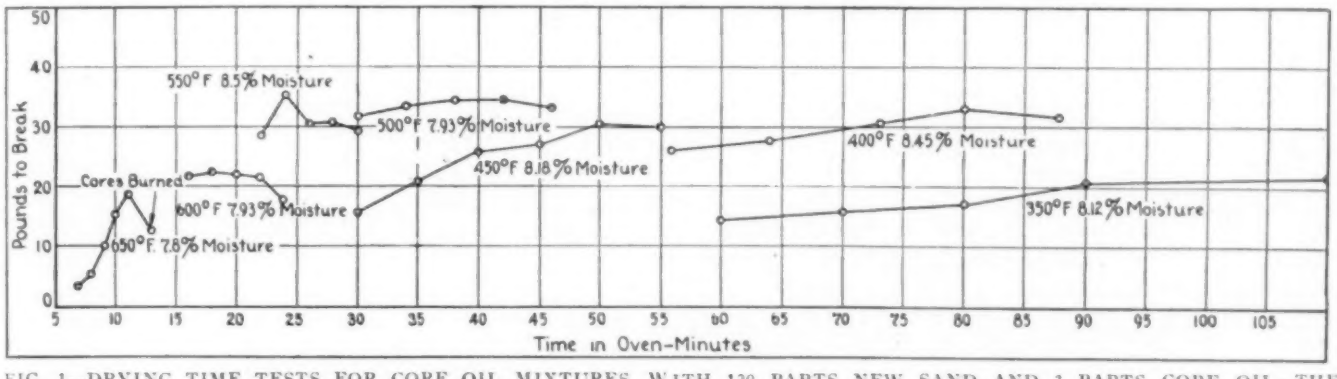


FIG. 1—DRYING TIME TESTS FOR CORE OIL MIXTURES, WITH 120 PARTS NEW SAND AND 3 PARTS CORE OIL—THE TESTS WERE MADE ON BRIQUETS HAVING A BREAKING SECTION ½ X ¼-INCH

Few Know Costs

It probably is true that few foundrymen know the cost of their core mixtures. They may be familiar with cost of core mixtures per ton of castings. However, to properly determine the choice of core mixtures to be used for different purposes, the value of each mixture for 100 pounds should be figured.

Taking the value of 75c per gallon for commercial oil mixtures, and $3.50 per ton for new sand, with a mixture of one to forty, 100 pounds of core mixture costs 32c for materials alone.

To compare with this, let us consider the value of 100 pounds of core mixture made from heap sand with a pitch compound as a binder. Using the value of 2¼c per pound for the pitch compound and nothing for the value of the heap sand, which in most foundries is thrown away being in excess of that necessary for molding, the value of the mixture is 3c per 100 pounds.

Now assuming that it were possible, which it is not, to entirely substitute such pitch cores for oil-sand cores, and assuming the figure of 800 pounds of core mixture per ton of castings, it may be readily seen that a reduction in cost of $2.32 per ton could be made.

On a basis of 500 tons of castings per month, this saving would be $1160 per month. If oil continues to rise, the saving would obviously be greater. However, it is entirely probable that for a foundry such as the one with which the writer is connected, it is advisable to use three general core mixtures, depending entirely on the cores in question. These mixtures are as follows:

The best possible oil-sand core amounting to 15 per cent by weight of the total core mixtures.

A medium priced core mixture using corn flour binders with 50 per cent new sand, for about 35 per cent by weight of the work.

Still cheaper pitch or paper mill

Paper presented at the convention of the American Foundrymen's association, held in Cleveland. The author is president of the Ft. Pitt Steel Casting Co., McKeesport, Pa.

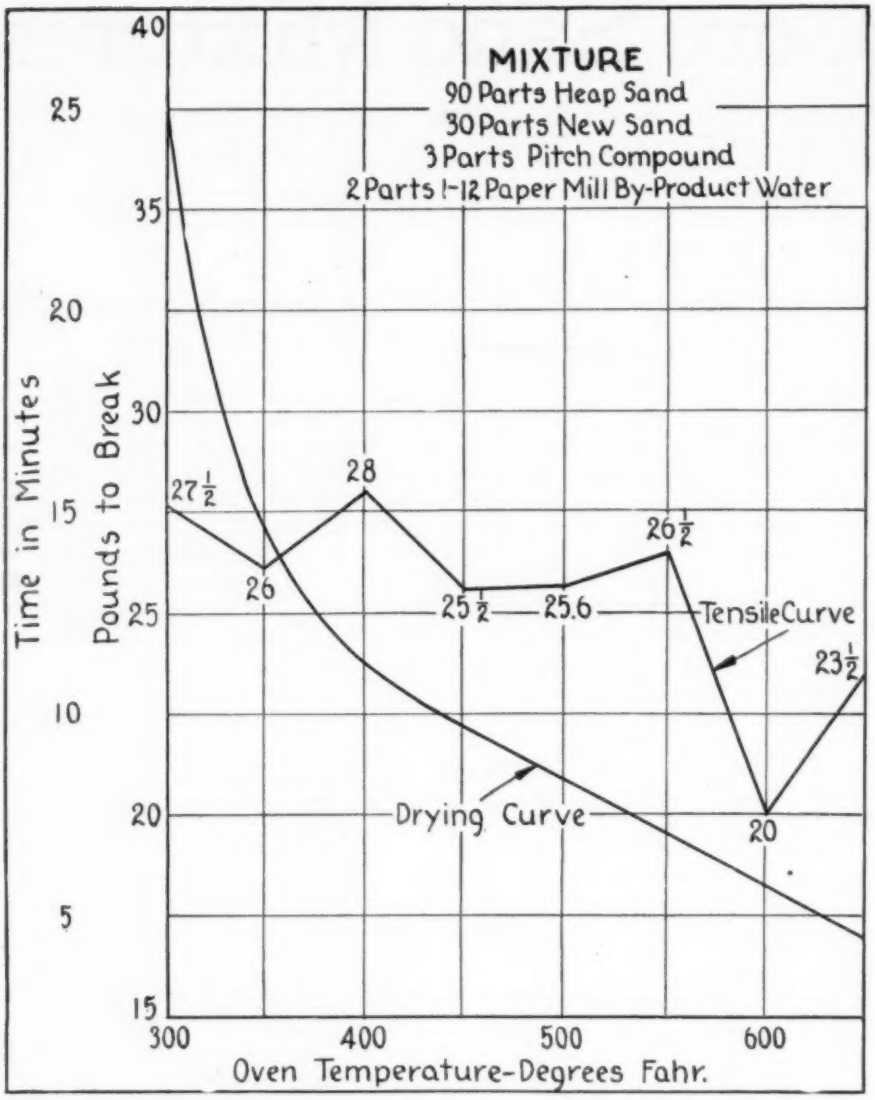


FIG. 2—TESTS OF DRYING TEMPERATURES AND STRENGTH OF CORE SAND MIXTURES USING CORN FLOUR BINDER—BREAKING SECTION ½ X ½-INCH—0.5 PER CENT MOISTURE

by-product cores with only 1/3 new sand for possibly 50 per cent of the work.

Extreme discretion should govern the selection of the mixture to use. In no case should a cheaper mixture be used if quality of the product is thereby affected. However, it appears to the writer that in the past practically all the cores in steel foundries making light work have been made from expensive oil mixtures using all new sand, although a large percentage, as stated before, could be made of cheaper mixtures.

Used Pitch Compound Cores

It may be of interest to know that for some months our foundry ran on a combination of 90 per cent pitch compound cores, and 10 per cent of a somewhat more expensive core mixture, with practically no oil-sand cores. However, it is not expected that such an extreme percentage of cheap cores is advisable in ordinary practice. The conclusion of this investigation was not to be made from laboratory experiments or short tests, consequently cheap cores were used for considerable lengths of time, although it was realized we had possibly gone beyond the danger point. The use of mixtures cheaper than oil-sand mixtures, requires much closer attention on the part of the executive of the foundry than if a core room were run on only oil mixtures.

It is human nature for those who are not directly interested financially to desire the use of materials which more or less take care of themselves. Making cores with a large percentage of heap sand, and with cheaper core compounds requires the close co-operation of the molding department and the core department, with a desire on the part of all to make such savings possible.

To anyone not particularly interested in making a financial saving, this paper is of little interest, and perhaps the conditions which exist today are not such as to lead most persons to be particularly keen regarding savings. This investigation was started some two years ago when everyone was endeavoring to save every dollar possible, and there is no telling when we will return to a like situation.

Mixtures Reduce Costs

It is quite possible with the proper selection of the cheaper mixtures to reduce the cost of core mixtures $1.50 per ton of castings. With values of materials remaining as they have existed for the past 6 months, and with the present mounting cost of linseed oil, this figure can probably be raised to $2 per ton. Based on a production of 500 tons per month, it readily can be seen that this amounts to a considerable item, and well warrants any foundry in taking up the question of cheaper substitutes for oil-sand cores.

It should be understood that the results which are given here are the

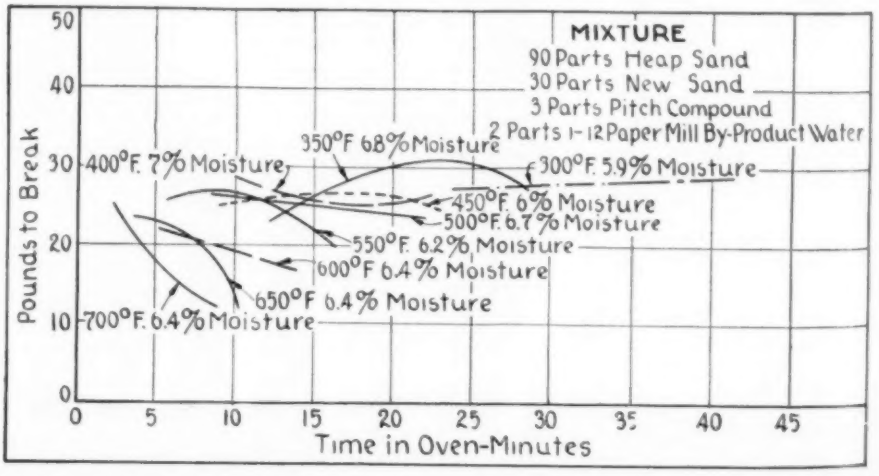


FIG. 3—TESTS OF DRYING TIME AND STRENGTH OF CORE SAND MIXTURES USING PITCH COMPOUND BINDER—BREAKING SECTION ½ X ½-INCH—SAND WORKED IN MULLER TYPE MIXER

actual findings. The only object of the investigation was to determine which compounds are best. It definitely can be stated that there are no better cores than those made from a proper proportion of suitable sharp sand and a good core oil. The only objections to them are the cost of the binder and the time required for baking, and for certain cores, the lack of green bond. As the remainder of this paper deals more or less with economical substitutes for core oils, those favorable to core oils should not feel that they have not received their fair share of consideration, or that the general good qualities of oil cores are not appreciated.

Replaces Oil Core

After an oil core is made it has every requirement of an ideal core excepting one; namely, its inability to yield on contraction of certain intricate designs, thereby producing cracks. A properly made oil-sand core has, among other characteristics, the ability to be stored for a great length of time, and in green-sand molding it absorbs less moisture from a mold than any other kind of core.

However, it was found after trying hundreds of mixtures in varying proportions, under all conditions, that extremely fine cores can be made at a reasonable price by a substitution of corn flower binders for oil. Their value rests in the fact that they will carry any degree of heap sand up to 100 per cent.

Cores made from them dry rapidly. The absorption of moisture during storing is practically negligible

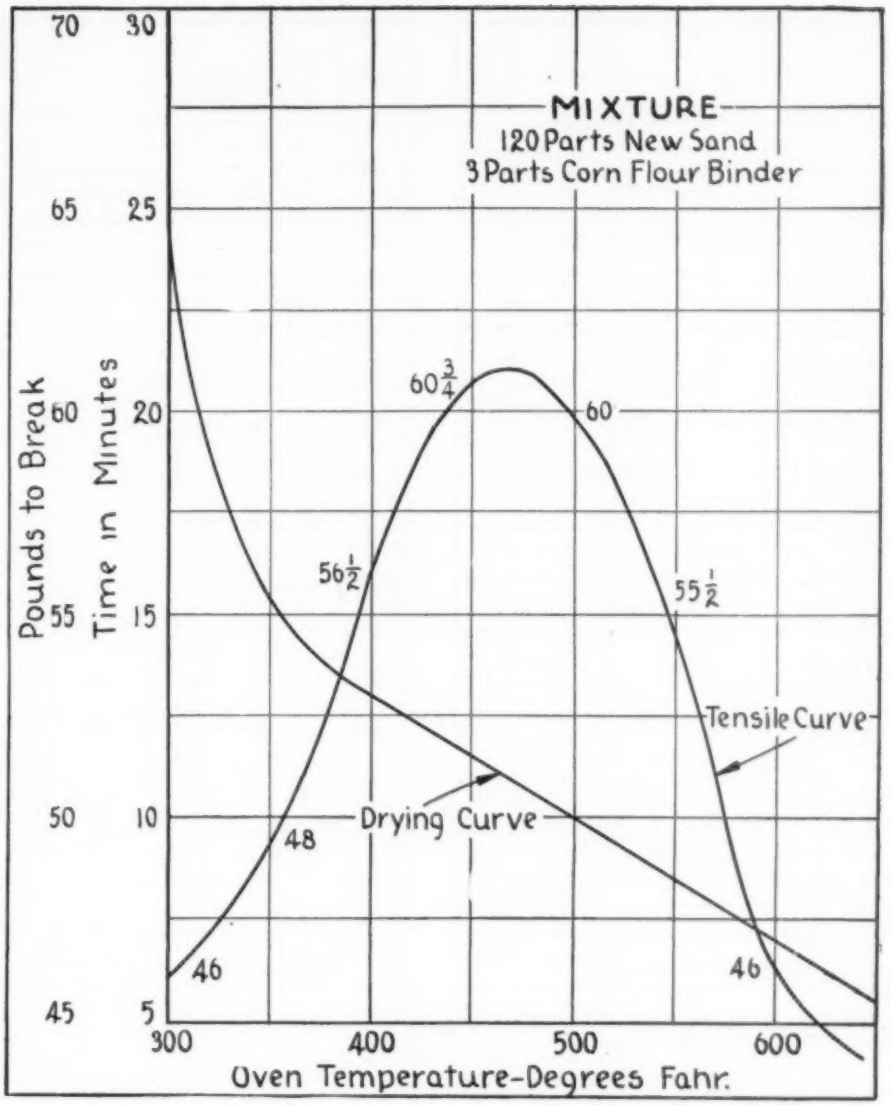


FIG. 5—TESTS OF DRYING TEMPERATURES AND STRENGTH OF CORE SAND MIXTURES USING PITCH COMPOUND BINDER—BREAKING SECTION ½ X ½-INCH—SAND WORKED IN MULLER TYPE MIXER

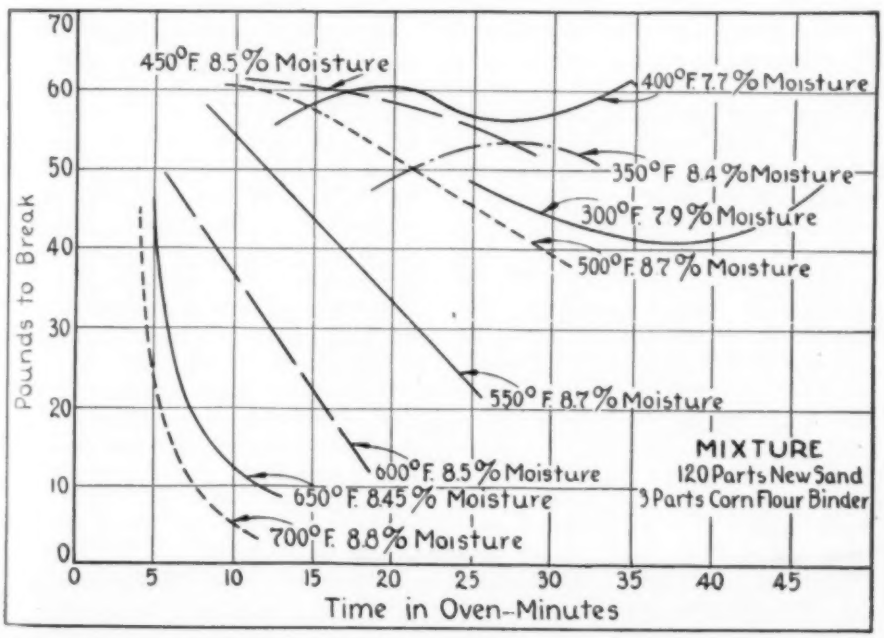
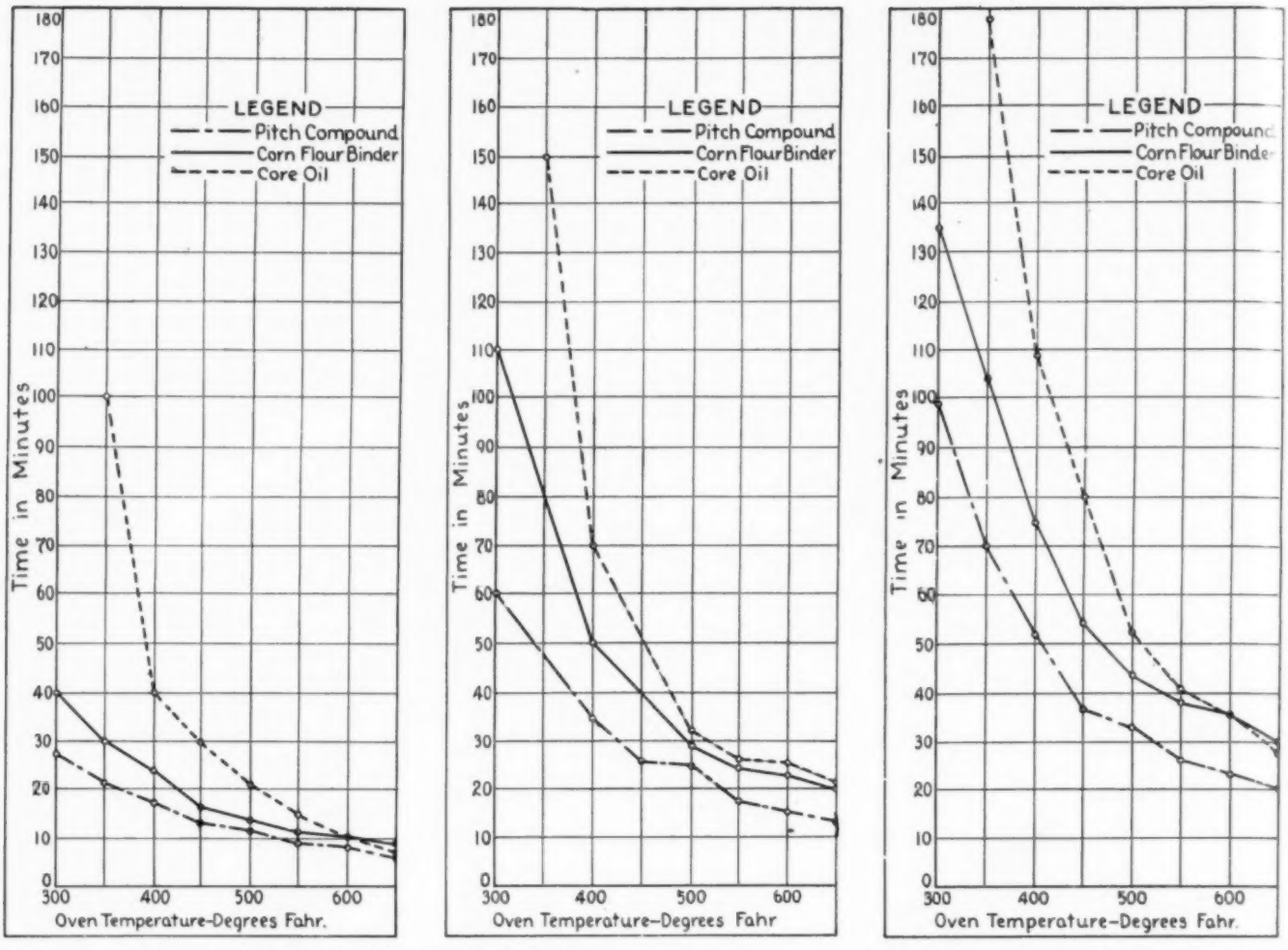


FIG. 4—TESTS OF DRYING TIME AND STRENGTH OF CORE SAND MIXTURES USING CORN FLOUR BINDERS—BREAKING SECTION ½ X ½-INCH

and the absorption of moisture in the mold, although considerable in excess of that of the oil-sand core, has not been found sufficient to give bad results. For example, cores have been left in green-sand molds for 66 hours, and while the cores at the end of that time appeared to have a skin which contained more or less moisture, it could not be found in any case that this affected the appearance of the castings.

Yield Under Pressure

Cores made from these compounds have another exceedingly desirable quality, namely, that they have a yielding power to the contraction of the castings, in excess of any other core compound used. Peeling quality of such cores is not quite equal to that of the oil core, but, in most cases, is sufficiently close to be just as satisfactory. Another desirable quality of cores made from these



FIGS. 6 TO 8—DRYING TESTS ON DIFFERENT CORE SAND MIXTURES IN 1, 2 and 3-INCH CUBES, RESPECTIVELY—THE PITCH MIXTURE WAS MADE OF 90 PARTS HEAP SAND, 30 PARTS NEW SAND, 3 PARTS PITCH COMPOUND, AND 2 PARTS 1-12 PAPER MILL BY-PRODUCT WATER—THE SAND CONTAINED 6.75 PER CENT MOISTURE—THE CORN FLOUR MIXTURE CONSISTED OF 120 PARTS NEW SAND CONTAINING 8.5 PER CENT MOISTURE, AND 3 PARTS CORN FLOUR BINDER—THREE PARTS OF CORE OIL WERE MIXED WITH 120 PARTS NEW SAND CONTAINING 8.25 PER CENT MOISTURE FOR THE THIRD MIXTURE

compounds is that the core sand has an increased green bond strength which is advantageous in making certain shaped cores when the use of dryers is not possible.

For the same reason the making of certain cores with the use of these compounds as a binder will take a trifle more work on the part of the coremaker than is the case with a straight sharp-sand oil core, owing to the fact that in bumping small core boxes the packing is not done as rapidly. However, this objection is more theoretical than practical, and will have weight only in certain shops where the speed of making oil-sand cores has been developed to a high degree of efficiency. Men accustomed to using other binders than oil will experience no difficulty.

Their particular value is, as already stated, that considerable heap sand can be used, the percentage being entirely governed by the tendency to burn in. In other words, the greater the proportion of new sand used, the less tendency will there be for the sand to adhere to the castings. Consequently, these compounds give an opportunity to vary the relative amount of new and heap sand according to the requirements of each case in question. The cost per hundred pounds of core mixture using one part of new sand and one part old sand with binder in a 1 to 40 ratio is 15c. Obviously the less new sand the cheaper will be the mixture.

Another substitute for oil sand found extremely economical is that of so-called pitch compound. It is possible for a foundry to make cores with air-floated pitch of good quality without the addition of any other compound, but it is quite probable that the addition of a certain amount of other ingredients to the pitch is of assistance in causing the cores more readily to release themselves from the castings.

This having been a well known fact for some time, various pitch compounds are sold with varying proportions of pitch and other ingredients. This matter has gone even so far that the purchaser may specify the percentage of other ingredients he desires in the compound.

A core mixture using a pitch compound and all heap sand can be made for 3c per 100 pounds. And again, as in the case of corn flour binders, any amount of new sand can be used, depending entirely on the necessities of the case. The price mounts as the proportion of new sand is increased. Using 1/3 new sand the cost is 9c per 100 pounds. The addition of a portion of new sand raises the cost of this mixture, but obviously it will not approximate the cost of oil-sand cores, because three quarts of a pitch core compound costs 2¼c and has practically the same bonding power as 2½ quarts of oil compound at 75c per gallon, or 49c.

In determining the class of cores which would be made of the cheapest mixture, it is obvious that they would be the larger ones with consequently a large saving in material. This is the reason, as before stated, that probably 50 per cent by weight of

the cores used in our foundries could be made advantageously from pitch compounds. The other qualities of pitch cores are that they absorb practically no moisture in storing, and that their strength does not materially decrease during this period, also that they do not absorb any unreasonable amount of moisture from the green-sand mold during a period of 48 hours, which is longer than cores remain in molds before pouring.

Green Bond Strength

The green bond strength of these cores is entirely dependent on the strength of the heap sand, as pitch in itself adds little if any green bond. If the heap sand is not sufficiently strong for the coremaker to use rapidly, the green bond strength can be increased by a slight addition of corn flour binder.

A desirable quality of pitch cores is the rapidity with which they can be dried. This feature is brought out more definitely later in the paper when the drying time of various mixtures is discussed. Recently we have found that a satisfactory, and at the same time a cheap core can be made using paper mill by-product with heap sand. Again any amount of new sand can be used. The value of 100 pounds of such a mixture, without any new sand is 1c.

Many believe that cores made with a binder of paper mill by-product are likely to absorb too much moisture while standing in the green-sand molds. This may be true in certain localities, but, as stated, if only a judicious amount is used, this is not as dangerous as may be imagined. Experiments made by us have shown no evil effects from a core which had outer coatings containing considerable moisture. It thus may be seen that it is possible to substitute for an extremely costly oil compound, other classes of compounds in a large percentage of the cores made. The degree to which this can be extended is entirely dependent on the degree of watchfulness of the organization and their desire to save money. Costs of different core mixtures are shown in the accompanying table:

Binder	Sand	Cost
All oil	All new sand	32c
Corn flour	All new sand	22c
Corn flour	50% new—50% heap sand.	13c
Pitch compound	All heap sand	3c
Pitch compound	33% new—67% heap sand.	9c
Paper mill prod	All heap sand	1c
Paper mill prod	33% new—67% heap sand.	7c

Cost figured on a 1 to 40 ratio.

The matter can be pushed to such an extent that the cheaper cores are used in places where they should not be used, with a result that the quality of the castings is harmed to the extent that excessive cleaning costs result, and may be carried to the point where a large amount of pitch is introduced into the heap sand of the foundry.

The writer hesitates to mention this fact as it is one which has not as yet been definitely determined at the plant with which he is connected. The matter was carried to the extreme; that is, a large portion of the cores were made of pitch compound, and owing to the fact that the production of the foundry was being greatly increased more heap sand was needed, and consequently, the cores were not separated from the heap sand. This was a most severe test, and whether or not the heaps were injuriously affected is questionable. There were slight indications at one time that an excessive amount of pin holes and small blows were produced, but as these have happened before, when no pitch cores were used, it cannot be definitely stated that they resulted from the use of pitch cores.

The percentage of moisture, and the temperature and rate of drying of various kinds of cores was found to be important. It was found that different core mixtures required slightly different percentages of moisture before being made into a core to yield a maximum strength. Consequently these determined percentages were used in each case.

Rammed Cores Stronger

It should be noted, of course, that in making such comparisons the cores had to be made in such a way that they were uniformly rammed. It is obvious that the harder the core is rammed when other compounds than oil are used, the stronger will be the core. This is all of such consequence that a great deal of time was spent in making cores which could be compared.

It was found possible to make cores from a box so arranged that the given

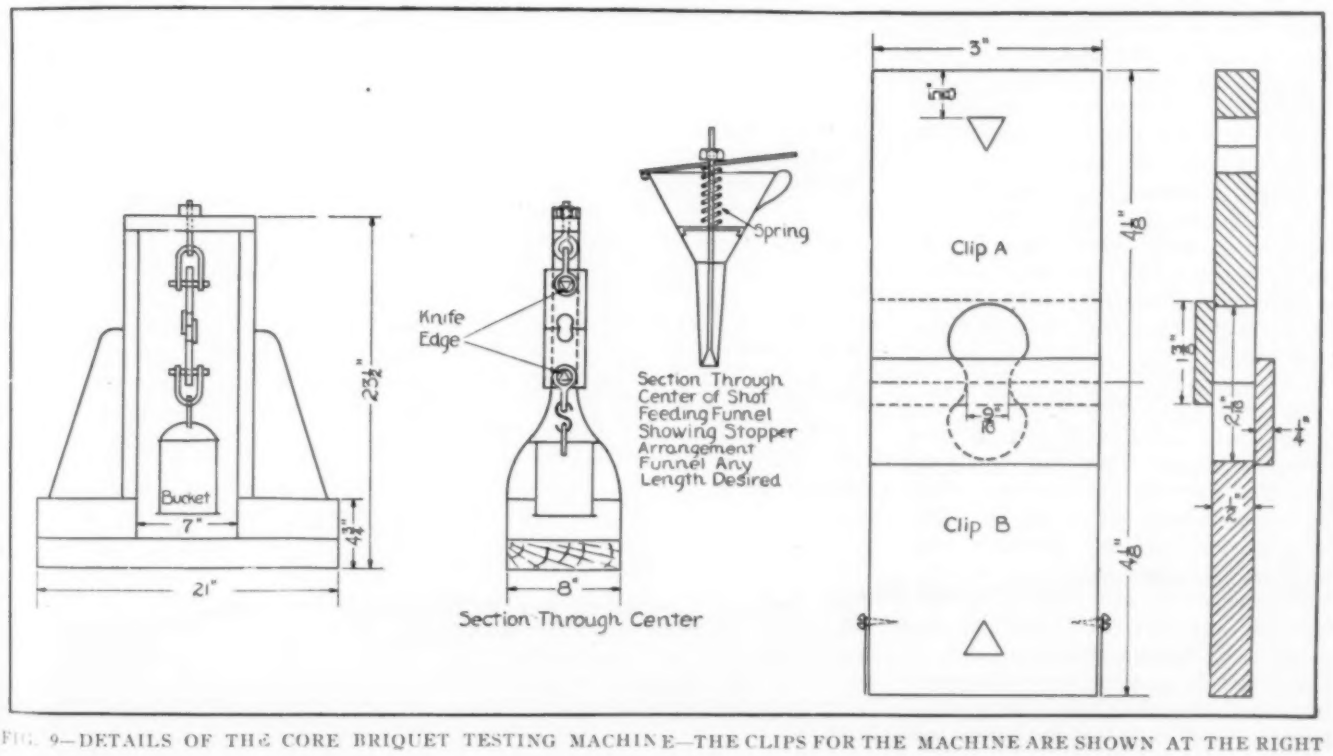


FIG. 9—DETAILS OF THE CORE BRIQUET TESTING MACHINE—THE CLIPS FOR THE MACHINE ARE SHOWN AT THE RIGHT

weight of sand could be compressed into a briquet core, or from a given volume of sand, because, as has been found in the investigation on cohesiveness tests carried on in the sand investigation, different sands are compressable to a different degree. However, O. H. Frederick, who conducted practically all these experiments, found that uniform cores could be made. Ten cores made from a given mixture varied only a slight amount from the average. The limits of variation were well within other errors liable in the consideration of the subject.

Fig. 5 illustrates two different features. The curved line indicates the time required for drying at different temperatures, the cores being tested in the dry state. The core mixture used was 90 parts heap sand, 30 parts new sand, with 3 parts pitch compound as a binder. The sand was mixed in a muller, and before being made into test cores contained 6.75 per cent moisture. The temperature line shows that the time of drying decreased rapidly as the temperature increased up to approximately 400 degrees Fahr., after which the speed of drying did not increase as rapidly. The line representing the strength indicates there was not much loss in strength unless temperature was over 550 degrees Fahr.

The chart, Fig. 2, is similar to that shown in Fig. 1, except that the mixture was all new sand with a corn flour product as a binder, at the ratio of 1 to 40. The moisture of the sand used was 8½ per cent. As in Fig. 1, the time of drying decreases rapidly up to 400 degrees Fahr., and slowly thereafter. As for the strength of the cores, it showed that possibly 450 degrees gave a maximum strength, and that the strength decreased thereafter. However, it brought forth one point not shown on the preceding chart, which is that in the case of the corn flour product as a binder, satisfactory strength was not obtained until 450 degrees Fahr. was used.

Baking Chart Shown

A series of tests giving the strengths obtained at different temperatures for different baking periods is shown by the chart, Fig. 3. The core mixture used was 90 parts heap sand, 30 parts new sand, and 3 parts pitch compound as a binder. The moisture was 6.75 per cent in the sand before being rammed into cores. From this it may be seen how rapidly cores can be baked at a high temperature but that at the same time the strength of the cores is materially reduced if baked too long at some high temperatures. In going down the scale of temperatures from 700 degrees Fahr. it may be seen that this line does not become horizontal until 500 degrees is reached. From 500 degrees to 300 degrees there is appreciably no decrease in the strength of the cores unless they are left in the oven an unreasonable length of time after they have come to the dried condition.

Fig. 4 indicates the same features as Fig. 3, but the sand was all new with a corn flour binder. The conclusions from this chart are similar to those drawn from the previous one, except that 500 degrees Fahr. appears to be a somewhat more dangerous temperature at which to dry these cores than was the case with the pitch compound cores. In other words a 500-degree line in the case of the core flour binders approximates the 550-degree line in the case of the pitch binders.

The chart shown in Fig. 1 indicates a similar experiment using a mixture of all new sand with a ratio of 1 to 40 core oil as a binder. This shows that the maximum strength is obtained anywhere from 400 to 500 degrees Fahr. It also shows the remarkable difference in drying times. This chart indicates that the maximum strength at the different temperatures was obtained according to the following table:

Degrees	Minutes
650	12
600	18
550	23
500	40
450	50
400	80
350	100

Having observed the effect of drying times on the cores as indicated by the previous charts, it was decided to make a separate and distinct series of experiments, and in place of using the ½-inch briquets, as in the previous cases, this experiment was carried on with cores 1-inch, 2-inch and 3-inch cubes.

Fig. 6 shows the time required to dry 1-inch cubes made from three different mixtures. They were all dried in the same oven at the same time, and the ideal percentages of moisture were used in each case; namely, 6.75 per cent for the pitch compound cores, 8½ per cent for the corn flour product cores, and 8¼ per cent for the core oil cores.

Referring to Figs. 7 and 8 for 2-inch and 3-inch cubes respectively, they show that at reasonable temperatures in all cases the pitch compound cores dried faster than the corn flour product cores, and the latter faster than the core oil cores. At approximately 550 degrees Fahr. the lines run fairly close together, but up to that point the difference is one of some importance. It may be seen from this that in those ovens which run at low temperatures the selection of the binder is of considerable moment as far as time of baking is concerned. It is shown that all characteristics shown by the cores for 1-inch cubes held for 2-inch and 3-inch cubes.

These charts show that there is an ideal time and temperature for various mixtures. This is one good reason for not using too many mixtures at one time in core room practice, or in other words there should be in an oven at a given time cores made from only one kind of binder in order to run the ovens most economically and to get the maximum strength from said binders.

Cores Not Sprayed

Results in all tests were obtained without spraying the cores. This subject is an extensive one in itself. Conclusions arrived at are that the quality of cores is materially increased by proper spraying. This is particularly true in the case of small cores. Reduction in the amount of core binders can be made if proper spraying is practiced. We found that a spray of water with an addition of a small portion of paper mill by-products gave excellent results.

If a new shop were to be started for making small steel castings, the writer would, judging from investigation we have made, simmer down all well known practices to the following:

A small amount of oil cores.
A somewhat larger amount of corn flour binder.
Possibly 50 per cent of cores from pitch and paper mill by-products compounds.

These mixtures would be properly milled, and oil-sand cores would be mixed with a sand having 8¼ per cent moisture, while sand for corn flour binder cores would have a moisture content of 8½ per cent, and for pitch cores 6¼ per cent.

In any of these core mixtures which at times might appear to be somewhat weak, the amount of the core binders would not be increased, but for the time being a small amount of paper mill by-products water, made up of one part compound and 12 parts of water would be added, watching carefully that the addition of this mixture did not render the cores too susceptible to an excessive absorp-

(*Concluded on page* 685)

Melting Small Malleable Heats

Malleable Iron Made in the Arc-Electric Furnace Gives Trouble in Annealing—Cost of Producing Small Quantities High and Expert Knowledge Required To Keep Out of Trouble

BY S. J. FELTON

THIS paper deals primarily with the melting of malleable cast iron in furnaces not ordinarily used for this metal, and the points discussed are mainly those in which the practice differs from that usually employed. The facts herein presented should be interesting to foundrymen contemplating production of malleable iron in small quantities in conjunction with gray-iron, steel, or brass foundries. Malleable iron can be melted in brass foundry crucible furnaces, but the small quantities produced, coupled with the difficulty in most cases, of obtaining sufficiently high temperatures, make this method impracticable with the usual installation. The use of the electric furnace in this field is considered later. High grade, free-annealing malleable iron can be melted in oil furnaces, such as are used in brass foundries, and the following discussion is based on the use of 500 and 1000-pound, horizontal, barrel-type, noncrucible, tilting furnaces, using oil as a fuel.

The pig irons ordinarily used for malleable are satisfactory, but they should be of small size, and care must be used each heat in getting representative pieces for the charge because of the small quantities used. Plain carbon steel, malleable scrap, ferrosilicon, and ferromanganese make up the other ingredients of the charge. Naturally, materials containing chromium should be avoided. Although carbon is not absorbed by the charge, crushed coke or other form of carbon may be added to retard oxidation of this element. Bought malleable scrap should never be used, as the analysis fluctuates greatly, and high sulphur is liable to be encountered. Slag, burned out millscale, or sand, make satisfactory packing materials for annealing. If the packing material becomes oxidizing in nature, it may be neutralized by coke additions. The melting furnace may be lined with either fireclay or silica.

The time of melting will ordinarily be under two hours and the melting losses will average about 0.40 per cent carbon, 0.30 per cent silicon, and 0.20 per cent manganese. As the change is rapid when the metal is hot, particular efforts must be made to cast and break fracture samples quickly, so as to catch the metal at the right point. Therefore, smaller samples and quicker cooling than used in air-furnace practice, must be had. A sample, cast in the impression made by the end of a shovel handle and water quenched after air cooling to below a red heat, is satisfactory. Ordinarily the metal is tapped on an almost white fracture showing a slight graphite precipitate. Although according to air-furnace practice this fracture in such a small, quickly cooled sample, would indicate high carbon and silicon, the metal changes so rapidly in the oil furnace that this fracture will give a heat analysis of about 0.90 per cent silicon, 2.50 per cent carbon, and 0.20 per cent manganese, if the mixture was made up taking into consideration the losses already indicated. The heat must be tapped quickly, and as the losses continue, while the metal is being poured from the furnace, the last part of the heat should be doped with ferrosilicon unless heavy work is being poured.

Precautions Are Necessary

Until one becomes thoroughly acquainted with the process, each heat should be analyzed as quickly as possible so as to get a line on just what the furnace is doing. Also castings should be broken to make certain that no graphite is present. The losses are liable to vary in different furnaces, and with different materials charged. If the metal comes down too slowly, steel may be added to aid oxidation; if too quickly ferrosilicon may be used. If considerable time is spent doping a heat, cognizance must be taken of the manganese loss and ferromanganese should be added. If thin work is to be poured, it is sometimes advisable to tap on a darker fracture than the one already mentioned, while for heavy work, a white fracture on a larger sample should be obtained.

For light work, the metal must be handled quickly in thickly lined ladles of not over 100-pound capacity. Unless the heats are running uniformly in analysis, the scrap for each heat should be kept separate, as fairly close figures on the mixture to be charged must be obtained in melting such small quantities of metal. If larger amounts of metal are needed, several furnaces may be run at the same time. This puts quite an analytical burden on the laboratory, but when heats are running smoothly, and the same materials are being charged, it is possible to obtain uniform results if a single silicon or carbon determination is run on each heat, provided a complete analysis is obtained on one heat from each furnace every day. However, before this method is adopted, one should be expert at drawing deductons from the fracture samples, and the furnaces must be well understood. The phosphorous and sulphur should run under 0.20 and 0.05 per cent respectively, and they remain practically constant during the heat. It must be admitted that the routine of sampling and analysis stated here probably seem somewhat haphazard to a strictly up-to-date malleable man, but the exigencies of the process necessitate just such procedure, and the uniformity of metal obtained under these conditions is surprising.

Oil-furnace malleable is a free annealing iron, thus soaking at 1600 degrees Fahr. for 48 hours and cooling at the rate of 10 degrees per hour gives complete annealing. In many instances quicker annealing than this is satisfactory. Practically any fuel which will maintain a temperature of 1600 degrees Fahr. in the oven is satisfactory. Some foundrymen caution against heating too rapidly, but I have used oil as a fuel in a 5000-pound oven which reached 1600 degrees Fahr. in 10 hours. However, the castings in the boxes, packed in mill scale, did not attain 1540 degrees Fahr. (their maximum temperature) for 32 hours after starting. It is interesting to plot a cooling curve, comparing the temperature of the castings with oven temperatures. The oven may cool at an average uniform rate of 10 degrees per hour while the castings cool at an average rate of 8 degrees per hour. The slope of the castings temperature curve will be closer to the horizontal than the furnace temperature line on account of heat evolution from the precipitation of proeutectoid graphite. From 1350 degrees Fahr. to 1200 degrees Fahr. the eutectoid graphite precipitation causes a *hump* in the castings curve, but from 1200 degrees Fahr. down, the two lines are parallel and close together. The

Paper presented at the Cleveland convention of the American Foundrymen's association. The author is instructor at the Ohio Mechanics institute, Cincinnati.

rates of cooling vary under different conditions. For instance, if sand is used as a packing material the cooling of the castings will be slower.

The electric furnace would seem to be an ideal medium for melting malleable iron. The high temperatures available will give sufficient fluidity to pour the thinnest castings with low-carbon metal. The temperature of the metal in the furnace is sufficient to cause carbon absorption, so that a weighted quantity of coke or broken electrodes can be thrown into the metal, and the exact carbon increase calculated. If necessary, the metal can be held in the furnace and a quick analysis made before tapping, as in open-hearth steel practice. However, the author has had considerable experience in melting malleable iron in arc-electric furnaces and believes that they are not practicable, except in special cases, because of annealing difficulties. It should be noted that arc-electric furnaces are mentioned, as I have had no experience with malleable iron in induction furnaces. My experience has indicated that electric furnace iron requires a furnace cooling speed of 5 degrees Fahr. per hour or under, to obtain complete annealing. It might be mentioned that with very thin castings, using a slightly oxidizing packing, results, comparable in ductility with normal malleable, may be obtained because of the aid given by partial oxidation of the carbon, which is similar to European practice.

I have used acid and basic furnaces of different types, and many variations in analysis, without overcoming this requirement for slow annealing. Lowering of manganese to correspond to the low sulphur of basic furnace practice, or raising the sulphur to give a better manganese-sulphur ratio had no noticeable effect. I have tried almost every conceivable combination of silicon and carbon, but never have been able to produce a free annealing metal. I also have used different annealing methods without being able to shorten the annealing time. The work of Honda and Murkakami*, indicating that graphitization depends on the catalytic action of CO and CO_2, led me to suspect that reducing conditions in the electric furnace may have had some effect on the metal. Mill-scale has been added and agitated just before tapping, without any improvements.

Exhaustive metallographic tests have thrown no light on the cause of this annealing property, but it is believed that the high temperature of the electric arc (about 6300 degrees Fahr.) is responsible. Gray iron undergoes a distinct hardening effect when melted or refined under the electric arc, therefore, it is reasonable to believe that this mysterious hardening influence is present in electric-furnace malleable and resists graphitization. That this hardening effect is permanent is indicated by the fact that electric-furnace malleable scrap, used with pig iron in oil-furnace malleable heats, produces castings which are not free annealing. It must be realized that malleable cast iron is a sensitive, delicately balanced material, and the fact that cupola malleable has different annealing characteristics than air-furnace malleable, makes it not so surprising that electric-furnace malleable also differs.

Although high quality malleable iron can be produced in small quantities, as herein outlined, the average foundryman should think twice before going into this field. Serious complications have developed in most shops where an attempt has been made to load up the gray-iron foundry superintendent with brass, steel, or malleable iron. The gating problems of malleable iron are much closer to steel than to gray iron, and the manufacture of malleable is a diversified industry in itself. In making small quantities the costs are high and trouble is liable to be encountered unless an expert is on the job, particularly at the start. Although the arc-electric furnace seems ideal for the melting of blackheart malleable, foundrymen should go slow on this medium until more progress has been made in cutting down annealing time.

*Iron and Steel Institute of Great Britain, No. 2 (1920).

Artistic Castings Made in American Sand

In proof of his contention that artistic castings can be made in local sand equal to those produced in special sand or even in sand imported from France, W. F. Uschmann, Nashville, Tenn., prepared the various castings shown in the accompanying illustration with a view of exhibiting them at the recent convention in Cleveland of the American Foundrymen's association. The castings are made from a special white metal alloy employed for many years as an alloy for patterns on account of its non-shrinkable qualities. Attention is directed to the fact that the castings required no chipping or grinding after they were taken out of the sand The only cleaning they received was from a soft wire hand brush. It is stated that the metal takes a beautiful finish and may be plated and finished as highly as Britannia metal or silverware. The casting with the letter P is a good example of how sharply small details like the radial lines have been reproduced. The casting in the center was made by employing a piece of lace paper for a pattern and the small casting representing a lady is only 1/32-inch thick.

INTERESTING EXAMPLES OF SMALL BRASS AND WHITE METAL CASTINGS MADE IN LOCAL SAND

Gives German Foundry Output

Comparison of Number of Plants and Production of Steel, Gray Iron and Malleable Foundries Demonstrates Condition of the Industry Influenced by the War

INTERESTING statistics of the German foundry industry recently have been issued in Berlin under the auspices of the government covering 1920 and previous years. No figures since 1920 are available, it being part of the policy of the German authorities at the present time to withhold statistics in virtually all cases until they are of little commercial value to Germany's foreign competitors. Before the war, German statistics were among the most complete, accurate and promptly issued in the world. Since 1918 they have been notoriously belated, in many cases incomplete and in others inaccurate.

However, the accompanying figures have been checked outside of Germany from independent sources of information and are believed to be reasonably complete and trustworthy. They are unusually interesting because there has not been much change in the German foundry industry since 1920, other than some increase in the production of castings, which is estimated, on the basis of pig iron output, to have been 2,315,000 metric tons in 1922, compared with 1,987,200 tons in 1920, as given in the accompanying table. The production of iron castings last year is estimated at 2,000,000 metric tons, compared with 1,734,300 tons in 1920. The output of malleable castings is believed to have been 68,000 tons compared with 50,000 tons in 1920. The comparative figures for steel castings are 200,000 tons in 1922 and 168,000 tons in 1920, while those for enameled or polished castings are 47,000 tons in 1922 and 34,900 tons in 1920. The number of foundries in Germany at the present time is about 1500. This figure does not include nonferrous shops, but only iron, steel, and malleable foundries.

In addition to 1920, the accompanying table gives figures for 1919, 1917, and 1913, thus enabling interesting comparisons to be made covering the German foundry industry before, during, and since the war. Two sets of figures are given for 1913, representing respectively the old empire and the present limits of German territory. These statistics have been compiled by the editor of *Wirtschaft und Statistik*, Berlin.

Comparing the present territory with the same area in 1913, we find that the number of iron, malleable, and steel foundries in Germany increased from 1488 in 1913 to 1508 in 1920, although the latter figure is slightly less than the total number of establishments in the prewar empire. In the Germany of the kaiser there were 1574 ferrous metal foundries. A large number of foundries were surrendered to France in Alsace-Lorraine and to Poland in Upper Silesia. The companies thus forced to liquidate were compensated by the German government in 1919 and 1920 by the payment of billions of paper marks. It was a condition of the compensation that a large proportion of the money realized should be reinvested in new plants inside the present boundaries of the Reich. This accounts for the increase since the war in the number of establishments within the limits of the present frontier, as compared with 1913. Unfortunately a considerable number, although by no means all, of these new plants were built in the Ruhr district and are again in trouble with a foreign power. Including these works it is estimated that the annual capacity of Germany's foundries is about the same today as it was before the war. In other words the losses occasioned by the treaty of Versailles have practically been made good, but unfavorable economic conditions since 1919 have not permitted Germany's casting shops to operate at much over two-thirds of capacity.

At the present time there are 5138 iron, malleable, and steel foundries in the United States, and about 3000 in Great Britain. Both of these figures are considerably in excess of the 1500 such establishments in Germany. The aggregate melting capacity of the American foundries is about four times that of those in Germany, while that of the British and German shops is about the same. The capacity of the ferrous metal foundries of the United States is therefore about double that of those in Germany and Great Britain combined.

The actual output of Germany's foundries has progressively increased since the war, although on account of the occupation of the Ruhr, the production this year may be less than 1922, but is not likely to fall below the figure for 1919 when the aggregate output was 1,804,400 metric tons. The first year after the war marked the low point in the German castings industry.

German foundries are now producing over a million tons of machinery castings a year compared with about one and a half million before the war. The output of cast-iron pipe in 1920 was 121,700 tons, or nearly as much as in 1917 when it was 123,000 tons, but considerably less than the production of 372,600 tons within the same borders in 1913.

The malleable output in 1920 was 50,000 tons compared with 76,200 tons during the height of the war, and 70,600 tons in 1913.

The production of steel castings, which was 165,500 tons in the empire in 1913, and 159,500 tons within the present boundaries in the same year, rose in response to war demands to the unusual figure of 617,500 tons in 1917, afterward falling to 157,000 tons in 1919, and recovering to 168,000 tons in 1920, with an estimated melt of 200,000

German Output of Ferrous Metal Castings

In Thousands of Metric Tons—1913 to 1920

Item	1913‡	1913*	1917*	1919*	1920*
Consumption of pig iron and scrap	3649.5	3423.0	3090.9	2039.7	2253.1
Aggregate annual production	3344.2	3136.7	2692.1	1804.4	1987.2
Iron castings, total comprising:	3024.5	2826.2	1956.2	1568.2	1734.3
Tool and furnace castings	129.2	125.3	65.4	65.1	79.2
Castings for sanitary articles	3.7	3.0	2.0	4.3	5.1
Cast-iron pipe	406.7	372.6	123.0	111.0	121.7
Machinery castings	1632.5	1558.1	1123.9	993.1	1084.4
Structural castings	108.9	98.6	34.2	26.0	52.0
Other iron castings	743.5	668.6	607.7	368.7	391.9
Malleable iron castings	71.0	70.6	76.2	48.5	50.0
Steel castings	165.6	159.5	617.5	157.0	168.0
Enameled or otherwise polished castings,					
total comprising:	83.1	80.4	42.2	30.7	34.9
Merchant casting	34.6	33.3	11.8	11.9	12.4
Castings for sanitary articles	37.4	36.7	8.3	9.9	13.2
Castings for the chemical and other industries	1.7	1.1	14.1	4.1	3.7
Miscellaneous	9.4	9.3	8.0	4.8	5.6
Number of foundries	1574	1488	1408	1467	1508

‡Former territorial area. *Territorial area of 1920 without the Sarre district. 3649.5 tons should be read as 3,649,000 tons, and the others likewise.

tons last year. This in excess of the prewar production.

The only other articles which show an actual increase in production today as compared with the prewar era are rough iron castings for sanitary articles and enameled or polished castings for the chemical industries. The former increased from 3700 tons in the empire of 1913 to 5100 tons in 1920, and the latter from 1700 tons in 1913 to 3700 tons in 1920. The increase in the production of castings for chemical purposes reflects the active conditions which have prevailed in this branch of German industry since the armistice.

The consumption of pig iron and scrap was 2,253,100 metric tons in 1920 compared with 3,423,000 tons in the same territory before the war. The increase in the proportion of scrap to pig iron has been very marked in recent years. In certain districts the consumption of scrap now exceeds that of pig iron, while for the whole of Germany the melt of scrap is 68 per cent of that of pig iron compared with 32 per cent in 1913. In 1920, 4.7 per cent of the pig iron consumed was imported, mainly from France and Luxemburg; this year the ratio of foreign pig iron used will be much higher, but the chief sources are now Great Britain and Czecho-Slovakia, practically none having been bought from France and adjacent countries since the occupation of the Ruhr in January.

Awards Will Stimulate Paper Interest

Announcement is made by the board of awards of the American Foundrymen's association that the author of any exceptionally meritorious paper on any phase of the foundry industry, presented at the forthcoming 1924 convention of the association, will be considered eligible for a prize under the terms of a deed of gift first announced at the Columbus convention of the association in 1920.

Four individual contributions of $5000 each from prominent men connected with the foundry industry, W. H. McFadden, J. H. Whiting, John A. Penton, the late S. J. Seamon, were donated, the income to be devoted to recognition of meritorious achievement in the foundry field. While the joint fund is handled as a unit, the wishes of the individual donors are respected and thus the income from the component elements of the fund are devoted to certain specified sections of that field. Thus the board voted that if a paper of outstanding merit is presented at the 1924 convention of the association it will be recognized by conferring on the author the W. H. McFadden medal. Presentation to be made at the 1925 convention.

At the annual meeting of the board of directors of the American Foundrymen's association October 1922 a permanent board of awards was created. It is self-perpetuating in that it is made up of the seven most recent living past presidents with the president just vacating office as chairman.

During the Cleveland meeting acknowledgment was made of deeds of gift prepared and executed by the donors on the one part and by the president and secretary of the association on the other part. The agreement is rather long but the following paragraph contains the essence: "It is the desire of the donor that an award, prize, medal or scholarship shall be conferred each year, if feasible, upon some person who shall by his individual effort have achieved very noteworthy results toward the attainment of those objects for which the association was formed."

A.F.A. Confers Honorary Membership

The board of directors of the American Foundrymen's association recently has confirmed the action taken at the business session during the Cleveland convention of the association in electing the retiring president, C. R. Messinger to honorary membership. It also confirmed the election to honorary membership of G. K. Burgess and H. Ries, both of whom have rendered the association valuable service, particularly in connection with the sand research work.

Dr. Burgess, who recently accepted the position as director of the U. S. bureau of standards, was for several years chief of the division of metallurgy of the bureau. When the joint sand research work was commenced, he accepted an invitation, to serve on the executive committee. In addition, he was until recently a member of the subcommittee on tests and through his connection with the laboratory facilities of the bureau was responsible for investigations which enabled the committee to formulate the sand testing methods which have been adopted as tentative standards.

Dr. Ries, professor of geology at Cornell university, was the pioneer in this country in investigating foundry sand testing methods, having made surveys of foundry sand deposits for Michigan and Wisconsin in 1904 and 1905. He is also a member of the executive committee on sand research, a member of the subcommittee on tests and is chairman of the subcommittee on geological survey work, which has induced the several states to undertake the investigation of foundry sand resources.

Merge World Foundry Thought

(*Concluded from page 652*)

The meetings of the congress will be held in the large central assembly hall of the school as shown on the plan, one of the smaller halls being set aside for the special sessions in the English language.

The exhibits will include displays from manufacturers in the United States, Great Britain, Belgium and Italy, as well as France. One of the chief American exhibits will be that of the Osborn Mfg. Co., Cleveland. This display is being arranged by M. W. Zeman, sales manager, who has journeyed to France for the purpose. A number of new machines will be shown in operation. This exhibit will be under the name of the French agents of the Osborn company, the Allied Machinery Co. de France, 19 Rue de Rocroy, Paris.

Machines of the latest type produced by the Tabor Mfg. Co., Philadelphia, will be shown in operation by the French agents of this organization, Fenwick Freres & Co., 8 Rue de Rocroy, Paris. The H. M. Lane Co., Detroit, will exhibit American foundry designs and construction methods.

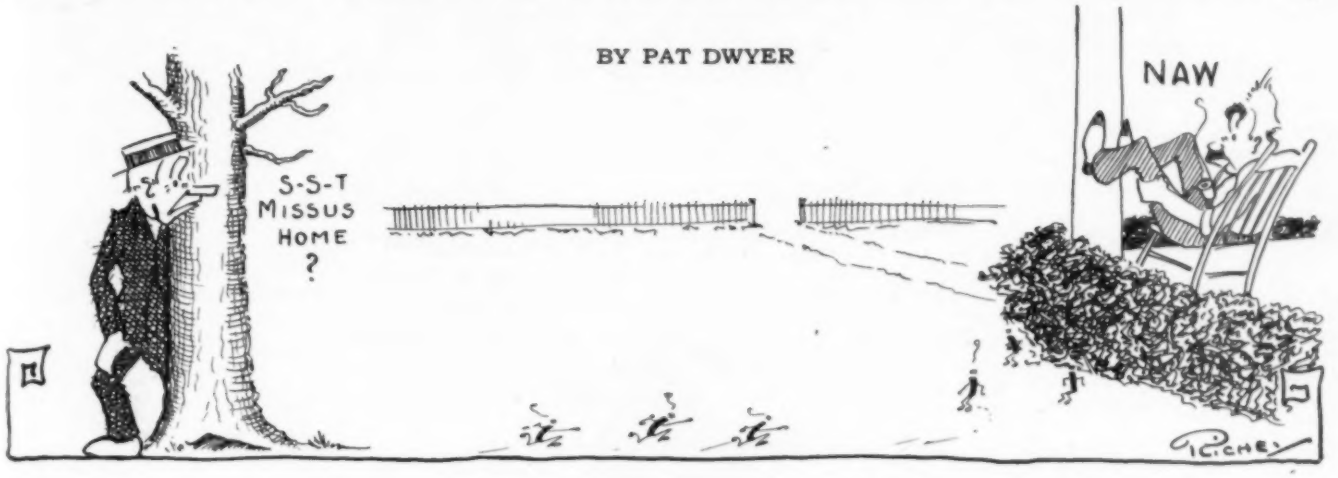
The booth of the Penton Publishing Co., publisher of THE FOUNDRY, together with *Iron Trade Review*, *Daily Metal Trade*, *Abrasive Industry*, *Marine Review* and *Power Boating*, will be in the center of the main exhibition hall as shown at *P* on the accompanying plan. It will be fitted up as a rest room for the convenience of visitors and will also include an exhibit of original photographs of the latest American foundry methods, together with specimens of the Penton publications and technical books. Cablegrams from America giving the latest iron, steel and metal market news, also will be displayed.

Among the principal British exhibitors will be the British and Continental Traders, Ltd., London; British Pig Irons, Ltd., London; and Kittell & Co., Ltd., London. These firms will exhibit various grades of British pig iron and foundry fuel.

The Belgian exhibitors will include the Lees Shipping & Trading Co., Antwerp, and the Societe Anon. d'Ougree-Marihaye, Ougree, Belgium, who will display pig iron and castings. Italy will be represented by the Soc. Anonima Materiali Refratteri, Livourne, Italy, which will display crucibles and refractory products. The French exhibitors are too numerous to mention in detail.

Bill Goes Into a Machine Tool Foundry

BY PAT DWYER



LAST night after the family had scattered as promiscuously and almost as noisily as a bursting skyrocket, I sat on the veranda for about an hour engaged in my favorite occupation of doing nothing, if one may include the quiet and peaceful sucking of an old cob pipe. Under certain circumstances, probably this gentle form of exercise may be regarded as requiring some little effort, but through fairly reasonable practice and application over a long period of years I have arrived at a stage where the act practically is automatic and synonymous with breathing. Indeed, the only lady in the country who occasionally honors me with her confidence and insists on mine at all times wonders—audibly—that I do not take the pipe to bed. Ever hear anything like that?

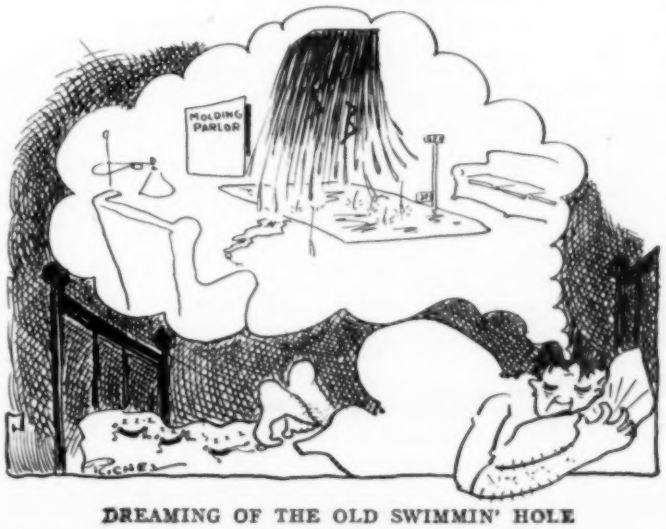
The idea, you know, simply is preposterous and just goes to show to what nonsensical extremes a vivid imagination and a lack of the proper sense of perspective will lead a person. You might say with a degree of justification that I should resent insinuations of that character. In fact that I should deliver an ultimatum, touching on certain person's preference for a glad hand or a strong arm. Whether my preference for sitting on the veranda instead of galivanting around to various places of amusement is due to the mental and physical limitations of advancing age, or merely is evidence that at last I am beginning to have some sense, I am not prepared to state, although, of course, I have my own opinion on the subject. However, the fact remains that when Bill came trickling around the corner about dark he found me alone, but with a spare chair available in which he parked himself with a grunt of relief. I told him that the chatelaine of the old ancestral castle was away on a vacation and that the younger generation was in various parts of the city for the evening. I intimated to Bill that conditions had changed since we were young. In those days people were satisfied with simple pleasures and did not consider it necessary to travel at top speed 24 hours a day.

Favors Vacations

"You're all right," said Bill, "but your memory needs to be rewound. It is commencing to unravel at both ends. I have worked all day and danced all night times without number and if you were willing or able to tell the truth you would admit spending your time in the same manner. As for vacations, I am willing to take one any time, winter or summer and expect to take one every chance I get as long as there is a shot in the locker and if the worst comes to the worst there is still the open road.

"I was doing some light and miscellaneous cruising this summer down in that particular section of the country known for some obsolete reason as New England. The term may have been appropriate enough at one time but to the casual observer, the country today, so far as the lay of the land and the look of the people are concerned, resembles its illustrious old namesake about as much as their respective emblems the eagle and the lion resemble each other; or, just about as much as the sacred cod resembles the golden calf.

"To an inland wayfarer who never has sniffed the bracing air that blows from over blue water and whose only knowledge of tacks and sheets, heaving decks, whistling spindrift and racing seas has been gained from a perusal of stories dealing with the lives of those who go down to the sea in ships and adventure upon deep waters, the term cruising only applies to traveling by boat. Down in that part of the country where I spent my youth, the term is applied promiscuously to any journey whether undertaken by water or by land and you know how tenaciously the colloqualisms of a man's mother tongue will remain with him throughout all the days of his life. I am aware of the fact that employes of lumber companies who may be sent to explore and appraise the value of standing timber on virgin areas are known as timber cruisers, but that is some-



DREAMING OF THE OLD SWIMMIN' HOLE

thing else entirely and has nothing whatever to do with the kind of cruising I am talking about."

"Cut out all the blinkin' references," I said, "and that also includes footnotes and explanatory paragraphs. You are worse than a modern book of travel. If there is anything I hate more than another it is one of those articles with unpronounceable foreign words and asterisks sprinkled over every page and with a flock of footnotes in almost illegible italics at the bottom. They always make me think of a man who stutters. Run up the big jib, take a firm grip on the wheel, make the necessary allowance for tide rips and cross currents and head her for open water. It does not make any difference to me whether you went cruising in a wind jammer, a canoe, a raft, under, over or inside a side door Pullman. I have tried them all at one time or another and although at present I am slightly out of practice I think I can follow you as cabin boy, cook, A. B., or ordinary hobo in any medium you may select for your present venture."

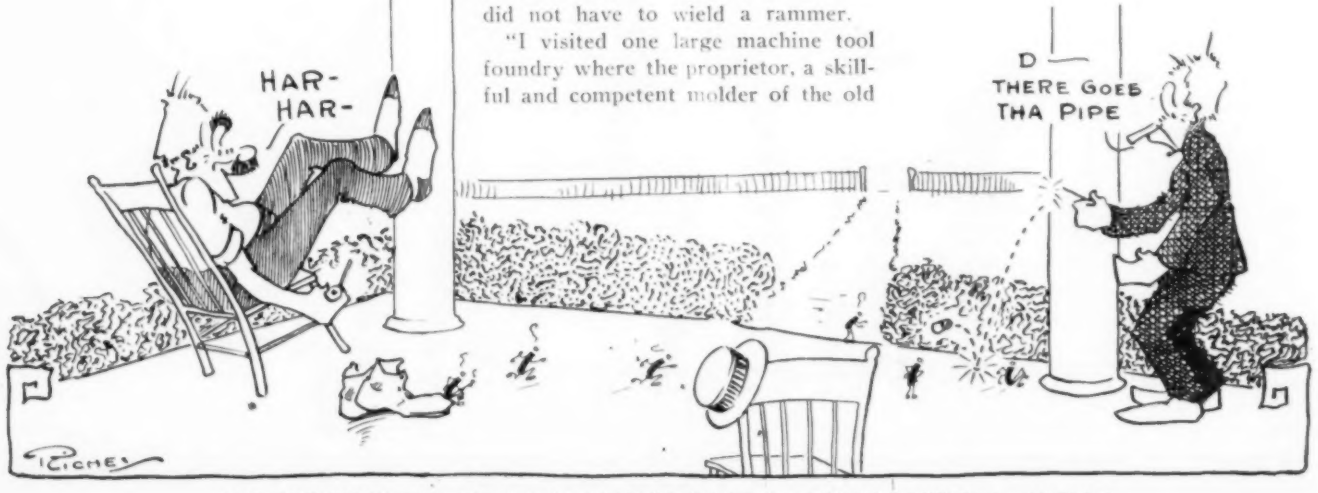
"Me lad," said Bill, "you are a treasure. Yeah, a rock in a weary land, a shelter in a time of storm. I have hopes, even after all the years I have known you that eventually you will develop into a human being. You are so prim and precise and grieve so easily and earnestly over a word that may be slightly out of plumb or a sentence that is not perfectly level and parallel with the gangway that really I considered I was doing you a favor when I presented the explanation of the term cruising. To be strictly truthful my motive also was tinged slightly with sympathy for your supposed ignorance. However, I am gratified exceedingly to find that you are in no immediate need either of explanation or sympathy. Let's be on the way.

"As I said some time back before you started this everlasting argument, I had a delightful cruise through certain parts of the eastern states early in the summer. Never mind what I was doing down there, when I went or when I came back. If you continue interrupting and asking what I believe are known as irrevelent questions I never shall get to the description of the incident I had in mind. An incident suggested by your reference to old times and to old-fashioned people.

"I visited several foundries, partly for pleasure and partly for information. The pleasure was derived from the fact that I was received with unfailing courtesy and kindness both from men I had met previously and from men whom I never had the pleasure of meeting before. Gentlemen all without exception as became master foundrymen. Incidently, my pleasure was increased by the reflection that I was merely a visitor and did not have to wield a rammer.

"I visited one large machine tool foundry where the proprietor, a skillful and competent molder of the old school, had been in business for over 30 years. As a young man he had started in a modest way and among many other interesting reminiscences I learned that several of his present employes had been with him continuously since he first had assumed the responsibility of running a business for himself. He was pardonably proud of his record as a successful business man and perhaps a trifle more so of his record as an employer who could hold the allegiance of his men over such an extended period of time. Illustrating this latter phase he told me the story of an incident that occurred a few years ago. One of his men was making a lathe bed mold in a part of the floor under a skylight that also served as a ventilator and which was provided with a cover that could be closed in winter or during a rain storm at any other season of the year. On this particular day the weather had been all that could be desired and the cover was not replaced at night. About midnight a violent wind and rain storm swept over the city and among other things the patter of the rain drops on the roof of his modest cot awoke the molder. The first thought that flashed into his mind was that the rain probably was pouring in through the opening in the foundry roof. He fully realized the advantage and in some cases the actual necessity of spraying the surface of his mold to keep the sand in good working order, but he did not believe in going to extremes. He was satisfied with a blow-can or with his own good old reliable mouth manipulated after the manner of Yee Wow while sprinkling his clothes. He

THE USUAL REWARD FOR A GOOD DEED



NOT THE FIRST PIPE THAT WAS SPOILED BY BEING SHAKEN OUT TOO QUICKLY

believed in temperance and moderation in all things. The vision of a cataract pouring through a hole in the roof denoted but one thing to his mind and that was a big muddy hole in the floor in the morning instead of the neatly finished and respectable mold he had left there on the preceding evening.

"It was another case of their's not to reason why, their's but to do and die and all that kind of thing. He immediately dressed and as the street car service was suspended after midnight, he tramped a distance of two miles through darkness and pelting rain and having arrived at his destination climbed up and replaced the cover. Then he entered the shop, pulled off his soggy shoes and drew on a pair of long rubber boots which he had in his cupboard, preparatory to making his way home.

Pinched on the Way Home

"He snuggled his old wet shoes up under his rain coat to protect them on the return journey and only had proceeded a few blocks when a night prowling policeman arrested him as a suspicious character. He indignantly protested and told old square toes who he was and also the nature of his errand.

"The guardian of the law said Har, Har, poked him in the ribs with the business end of his club and told him he had his own opinion of men who prowled around town in a rain storm after midnight carrying suspicious looking bundles parked under a raincoat. As an after thought he added reflectively that in all his experience he never had known a molder who owned more than one pair of shoes at one time and that pair usually resembled something that had been discarded by the old clothes man. He marched him down to the police station where a sergeant in a burst of generosity and with an almost human glimmering of common sense consented to telephone the owner of the foundry with a view of establishing the prisoner's identity and more or less extremely questionable veracity.

"The owner was sleeping peacefully in his Louis XIV mahogany bed inlaid with mother of pearl and other insignia of great wealth when the cry of distress came floating in out of the wilderness. No evidence is available in support of the contention, but I think we are reasonably safe in assuming that he was snoring discreetly after the manner of a man in his own house, blessed with a clear conscience and a digestive system as smooth and perfect as a twin six running in high on an ideal pavement.

"The jangle of the telephone bell brought him up with a final snort and muttered malediction in the heads collectively and singly of every person connected with the telephone system from the man who invented it to the night operator and the imbecile on the other end of the wire. However, his mental faculties turned a complete somersault after he received the message. He promptly threw on a few clothes, hopped in his machine and 'believe me,' he said in telling me the story, 'those 2-mile-a-minute speedway birds had nothing on me in the way I scorched down to that station.'

"He whirled around the corner of the station on two wheels, or maybe it was only on one, shut off the engine, jammed on the brakes and bounced into the presence of the sergeant in two jumps.

"He modestly admitted that he had served several terms as an alderman and during his term of office had established some slight reputation as a boy whose eyes usually were open and who had the somewhat disconcerting habit of calling a spade a spade. The members of the police department knew him because—Oh, well, never mind—that is another story. They knew him and he had no difficulty in rescuing his henchman from the clutches of the law.

"He drove him home and on the way out asked him why in the name of the piper who played before Moses, Pontius Pilate's bobtailed billy goat and other forms of profanity more appropriate to his auditor's knowledge of the classics, why he had not notified him of the condition in the shop instead of rambling down in the rain.

" 'Arragh, sure,' said the lad, 'I tought ye would be in bed an' I did not want to bother ye. Anyway it is not a fit night for a dog to be out.'

He Meant No Harm

"The entire naivette of the thing struck the boss so forcibly that for once his ready tongue failed him and he relapsed into the foundry vernacular. He told his companion affectionately to go to hell.

"After hearing this story and others of a somewhat similar character dealing with the *esprit de corps* that prevailed among the employes and the pride which they took in their work I had no difficulty in understanding how they turned out such presentable castings.

"As a result of such an extended experience in the manufacture of machine tool castings, an experience based originally on his actual contact with the work in his early years as a journeyman molder, the proprietor has developed an almost uncanny instinct in avoiding the pitfalls incident to the production of this class of castings. If a customer sends him a pattern which in his judgment is ill proportioned or designed to be molded in a position which will involve undue contraction strains or which will warp while cooling, he refuses to accept it unless the customer is willing to have it changed to meet his requirements.

Highly Skilled Molders

"Lathe beds and other long castings almost invariably warp out of line while cooling and he can foretell to a hair just how far any given casting will spring and camber his pattern correspondingly to overcome this tendency. His molders also are highly skilled and turn out castings in green sand molds, that with less skilled men are only possible in skin dried or dry sand molds and with a prolific use of dry sand cores. The advantage of this method is perhaps no place more noticeable than in the entire absence of the pernicious habit that obtains in too many foundries, the promiscuous nailing of all exposed surfaces.

"A beautifully finished mold for a 30-foot lathe bed was open in the floor the day I happened to visit the foundry and I had an opportunity of seeing many of the details. The pattern had been of plain box construction and had been accompanied by the necessary coreboxes to form the entire interior of the mold in dry sand cores. The foundryman recognized the value of cores under certain circumstances, but he also knew how much they cost in time, binder, new sand and fuel. He preferred green sand on which he saved the expense of all these items with the exception of time.

"Instead of making arbors for dry sand cores he made a set of lifting plates provided with lifting hooks and placed them in the bottom of the coreboxes. In addition to other advantages, green sand cores do not offer the same resistance as dry sand cores to the contraction of the casting and that represents quite a factor in the production of long castings containing many transverse ribs. Two upright runners were provided at each end connected with narrow gates at the bottom through which the iron entered the mold in such a manner that the stream flowed in a straight

line between the vertical walls of the mold and the cores without impinging on either. The gates are set so skilfully and the flow of the iron is gaged so accurately that it is not necessary to surface nail the walls of the mold in the immediate vicinity. In making the lathe mold a level bed first was laid out in the bottom of the pit. Two parallel rows of cores were laid on this bed to form the V-guides and the pattern was lowered until it rested on these cores. These cores were all made to a standard thickness, but the molder filed enough sand off the back of the end cores to compensate for the anticipated spring in the casting."

"Do you know, Bill," I said, "I often think that it is a positive shame that men who are competent to turn out work of that character, men who have spent their lives in acquiring such a high degree of skill and knowledge of the many factors involved in the casting industry, should not receive a more fitting recognition, financially and otherwise."

"Right ye are me lad," said Bill. " 'Tis true he enjoys that peculiar and legitimate craftsman's pride each time he sees in the cleaning room a casting, the result of his labors, smooth, shining, true to dimensions and with scarcely a fin; but I think he deserves more than he gets. Perhaps some day when the last of the old time molders has passed away, when he has laid down the tools for the last time, when the skilful fingers that were wont to touch delicate bodies of sand as lightly and tenderly as a mother stroking the cheek of the child at her breast, when these same fingers are folded peacefully over the honest old heart that beats no more, a grateful industry may erect a monument to his memory in the hall of fame. Perhaps it will," said Bill, as he knocked the ashes out of his pipe and prepared to go, "but I am inclined to think that it won't. This is a hard little old world. Goo' night."

Construction Features Useless Detail

BY M. E. DUGGAN

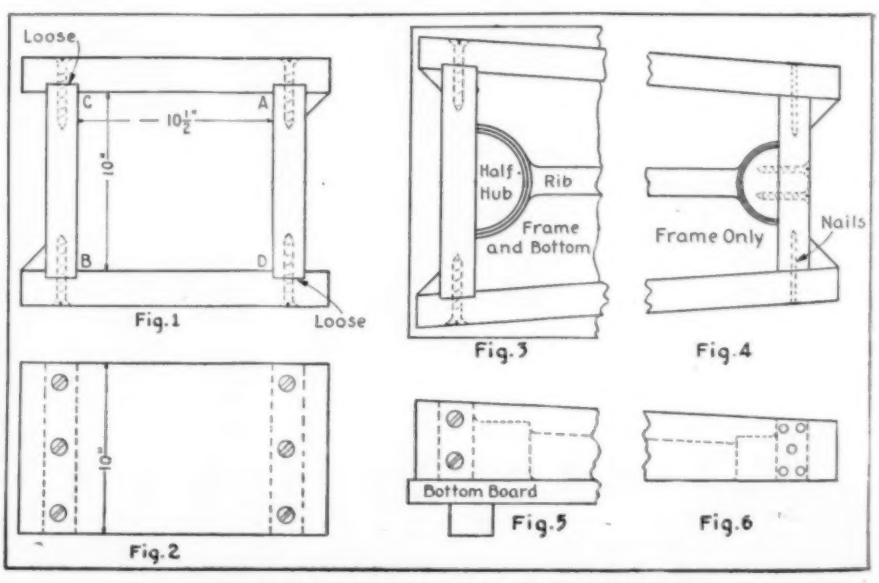
WHILE serving an apprenticeship all the trade of patternmaking I was taught to make coreboxes after the style shown in Figs. 1 and 2 where the sides are grooved to receive the ends. Two opposite corners as at *A* and *B* were securely fastened with glue, screws or nails and reinforced on the outside with corner pieces. The two remaining corners *C* and *D* were made loose so that the two halves of the box could be drawn away from the core laterally. On a large corebox I was instructed to attach these corners temporarily with one, two, or more wood screws, depending on the size of the box. A ring of black shellac was drawn around the vicinity of each wood screw head to assist the coremaker in finding it. The screws were designed to hold the box together while the sand was being rammed. Then they were to be removed before the box was taken away in halves.

I followed that method for many years and probably would have continued indefinitely if I had not been called to the foundry one day where I had an opportunity of watching the coremaker. He did not attempt to remove the screws in the detachable corners for the purpose of withdrawing the halves of the corebox sideways. He simply rapped the sides and ends of the box a few times with a hammer and then lifted the entire corebox up from the core. I asked a few questions touching on the manufacture of this and other cores and as a result. I discovered that a great deal of work on loose corners is time and labor wasted. With but few exceptions a corebox made fast at all corners is preferred by the coremaker.

Another style of corebox is shown in Figs. 3, 4, 5 and 6 in which the coremaker's requirements frequently are overlooked by the patternmaker who is not familiar with foundry practice. A broken section of the box as it usually is made is shown in Fig. 3. The frame is cut and fastened in the same manner as the box shown in Figs. 1 and 2. A rib on the inside of the box, also half hubs and a frame are fastened to a bottom board as shown in Figs. 3 and 5.

Recessing the sides of the frame and providing a bottom board are forms of unnecessary expense where only one or at most a few cores are required. A plain frame cut and fastened in the manner shown in Figs. 4 and 6 will meet the requirements of the coremaker. The rib and half hubs may be fastened in place with wood screws. The box is laid on the coremaker's bench, where the sand is rammed in the usual manner, the box and core are rolled over on the drying plate and the open frame is lifted away from the core. Usually a coremaker prefers a form of box construction where he may observe the core as the box is being lifted.

The objection to this form of construction from a patternmaker's point of view is that the coremaker's bench frequently presents an uneven surface which will be reproduced on the face of the core. In the event that such is the case, the coremaker easily can scrape the face flat with a straight edge after the core is rolled on to the plate. In many cases a patternmaker's work would be greatly lightened if he were to familiarize himself with foundry practice.



CONTRASTING TIGHT AND LOOSE CORNERS

British Submit Specifications

Tentative Cast Iron Specifications Submitted for Adoption to the General Council of the Institution of British Foundrymen by the Branch Committee —No Chemical Requirements Have Been Included

THE Institution of British Foundrymen recently has put out the tentative specification for gray-iron castings, shown in the accompanying table. This specification has been prepared for acceptance to the general council of the institution by the following committee:

J. Cameron, Cameron & Robertson, Kirkintilloch, representing the Scottish branch.

F. J. Cook, Rudge Littley, Ltd., West Bromwich, representing the British Cast Iron Research association.

W. J. Evans, Leys Co., Derby, representing the East Midlands branch.

F. H. Hurren, Rover Co., Coventry, representing the Coventry branch.

C. Heggie, Brookes Co., Birmingham, representing the Birmingham branch.

J. Hyde, R. Hyde & Sons, Chesterfield, representing the Sheffield branch.

W. Jolley, Metro. Vickers, Barrow-in-Furness, representing the Lancashire branch.

W. Lambert, John Stone & Co., London, representing the London branch.

A. Poole, Keighly Laboratories Ltd., Keighley, representing the West Ridings branch.

H. J. Young, N. E. Marine Engineering Co., Newcastle, representing the Newcastle branch.

J. Shaw, Chairman, Brightside Foundry Co., Sheffield, representing the Convenor branch.

In explanation of the specifications the committee has written:

The following proposals are put forward for consideration by your council. The committee, in doing so, quite recognize that the proposals do not cover all points at issue, such as castings with greatly varying sectional thickness.

Chemical composition has also been left out until our knowledge of its effects are more complete.

What the committee does claim is that the specification will do away with the anomalies now so frequently met with where a small diameter tensile bar is returned as giving a large breaking load, due to the quick cooling action on the structure of the metal, even when cast with a soft iron—or where fixed breaking loads are specified on the one sized bar, without any reference to the thickness of the casting it represents—or the use of B. E. S. A. tests by engineers, to castings, not intended by its authors.

The specification is at least an honest attempt to place the application of physical tests to cast iron on a basis that will be acceptable, and to

Tentative Cast Iron Specifications

1. **Process of Manufacture**—No castings shall be made from direct blast-furnace iron without consent of the purchaser.

2. **Classification**—The castings shall be required to pass the tests specified here, according to classification. The class of casting shall be specified on the drawing and also on the inquiry.

Class A: Important Castings—Test bars shall be cast on when possible. When it is not possible to cast the bar on the casting, or when the consent of the engineer is obtained to cast the bar separately, the same procedure as outlined in Class **B** shall be followed.

Class B: Other Castings—Where these call for physical tests, the bar may be cast separately at the option of the foundryman. The requisite test bars shall be preferably cast in duplicate sets of two bars each of the diameter specified in Section 3. Two bars are to be cast in a flask; and the mold to consist of green or dry sand according to whether the casting is in green or dry sand. They must be cast from the same ladle of metal as the castings they represent, and as near the same pouring temperature as possible. Any thermal or mechanical treatment of the test bars must conform with that to which the main casting is subjected, and the test bars must be left in the mold until nearly cold. The bars may be tested for transverse strength as cast or skin machined at the option of the purchaser.

3. **Size of Test Bars**—The thickness of any casting shall determine the size of the test bar required, namely:

Bar 0.875-inch diameter cast 15 inches long, for all castings where no main cross section of the metal exceeds ¾-inch thick.

Bar 1.2 inches diameter cast 21 inches long, for all castings where no main cross section of the metal exceeds 2 inches thickness or is less than ¾-inch thick.

Bar 2.2 inches diameter cast 21 inches long, for all castings where no main cross section of the metal is less than 2 inches thick.

4. **Transverse Test**—The transverse test specimens, specified in Section 3, when placed horizontally upon supports 12 inches apart in the case of the 15-inch bar and 18 inches apart in the case of the 21-inch bar, and tested under a centrally applied load, shall conform to the following minimum requirements:

		——Class A——		——Class B——	
Diameter of Bar, inches	Centers, inches	Breaking load, pounds	Deflection, inches	Breaking load, pounds	Deflection, inches
0.875	12	1,185	0.12	1,050	0.10
1.20	18	1,950	0.15	1,715	0.12
2.20	18	10,000	0.12	9,000	0.10

Any bar 0.125-inch over size must be turned down to standard. The following table gives the allowance to be made for each variation of 1/20-inch above or below standard diameters, assuming the sides to be round and parallel.

Dia. in inches	Class A, pounds	Class B, pounds
0.975	1,639	1,453
0.925	1,400	1,240
Bar 0.875	1,185	1,050
0.825	978	880
0.775	823	729
1.30	2,479	2,180
1.25	2,204	1,938
Bar 1.20	1,950	1,715
1.15	1,715	1,508
1.10	1,502	1,321
2.30	11,426	10,280
2.25	10,697	9,628
Bar 2.20	10,000	9,000
2.15	9,334	8,400
2.10	8,696	7,828

5. **Tensile Test**—The tensile test shall be made from one portion of the broken transverse bar, and when turned shall conform to the following dimensions for at least 2 inches in the center.

Bar 0.875-inch diameter to be turned to 0.564-inch diameter in the center = 1 square inch area.

Bar 1.200-inch diameter to be turned to 0.798-inch diameter in the center = ½ square inch area.

Bar 2.200-inch diameter to be turned to 1.785 inches diameter in the center = 2.5 square inch area.

The minimum requirements as to tensile strength shall be:

	——Class A——		——Class B——	
	Tons per sq. in.	Pounds per sq. in.	Tons per sq. in.	Pounds per sq. in.
Bar 0.875-inch diameter turned to 0.564-inch diameter	12.0	26,880	10.0	22,400
Bar 1.20 inches diameter turned to 0.798-inch diameter.....	11.0	24,640	9.0	20,160
Bar 2.20 inches diameter turned to 1.785 inches diameter.....	10.0	22,400	9.0	20,160

6. **Additional Tests Before Rejection**—Should the first test fail, the inspector shall try the second set, or if the bars represent a number of castings from the same mixture, test bars may be cut from any selected casting at the option of the manufacturer. If these tests fail, the casting or castings shall be rejected.

7. **Chemical Analysis**—Where physical tests are specified the amount of any chemical element other than phosphorus shall not be specified, and then only its maximum percentage.

8. **Inspection**—The representative of the engineer (or purchaser) shall have free access to the works of the manufacturer at all reasonable times during the course of manufacture of the castings; he shall be at liberty to inspect the manufacture at any stage, and to reject any casting or material that is unsound or does not otherwise conform to the terms of this specification.

9. **Testing Facilities**—The manufacturer shall supply and prepare all test bars at his own cost. Failing facilities at his own works for making the physical tests, the manufacturer shall bear the cost of carrying out the tests elsewhere.

the best interests of both manufacturer and purchaser.

The committee, while recognizing the simplicity one size bar with varying loads would give, came to a practically unanimous decision to adopt three sizes of bar, each of which would bear some relation in thickness to the casting it represented. The British Cast Iron Research association has since independently arrived at a somewhat similar conclusion.

Round bars were adopted because they are not so liable to surface cracks and strains as bars with a square or oblong section, and also because the crystalline formation does away with the diagonal lines of weakness found in a square bar. It may be observed that we do away with sharp corners and angles in castings where possible.

For thin castings, the 0.875-inch diameter bar is put forward because it falls into line with several B. E. S. A. specifications. For castings of medium thickness, the 1.2-inch diameter bar is specified. This diameter of bar was accepted by the British representatives at the last international testing meeting, provided the length of the bar was such as to give correct deflections. We are pleased to state that at the recent American convention Walter Wood, vice chairman of the American Society for Testing Materials committee on cast iron, put this forward as the international bar so as to fall into line with our specification. This will enable comparisons to be made in both countries, as the majority of tests will be made from this size bar.

While the majority of the committee was in favor of machining the transverse bars, it was pointed out that this involved such a heavy expense to pipe founders and others who make a large number of bars daily, that the question was left optional; the more so because the round bar does away with most of the surface cracks, etc. A clause is also inserted covering the treatment of the bar where the casting received the growing practice of heat treatment.

With regard to the loads specified, the committee wished to at least maintain present day practice. A forward movement to improve the quality may come later. The loads for the transverse correspond to 34 and 30 hundredweight (3808 and 3360 pounds) on the 2 x 1 x 36-inch centers bar, and 25½ and 22½ hundredweight (2856 and 2520 pounds) on the 1 x 1 x 12-inch centers bar, for Class *A* and *B* respectively. The load obtained on the 1.2-inch diameter x 18-inch centers bar when multiplied by the constant 1.96 will give the equivalent load on the 2 x 1 x 36-inch centers bar. To obtain the equivalent figure for the 1 x 1 x 12-inch centers bar from the load on the 1.2-inch diameter x 18-inch centers bar, multiply by the constant 1.47. Mathematically the constants given are correct, but it was found from the results obtained in breaking several hundred bars that the round bars gave much higher results when compared with square bars cast from the same ladle, than the formula equivalent, due to the causes mentioned before.

The figures, 1950 pounds for class A and 1715 pounds for class B, given for the 1.2-inch diameter x 18-inch centers bar, are also equivalent to the highest figures, 3300 and 2900 pounds, given in the present American specification for a 1.25-inch diameter bar tested at 12-inch centers.

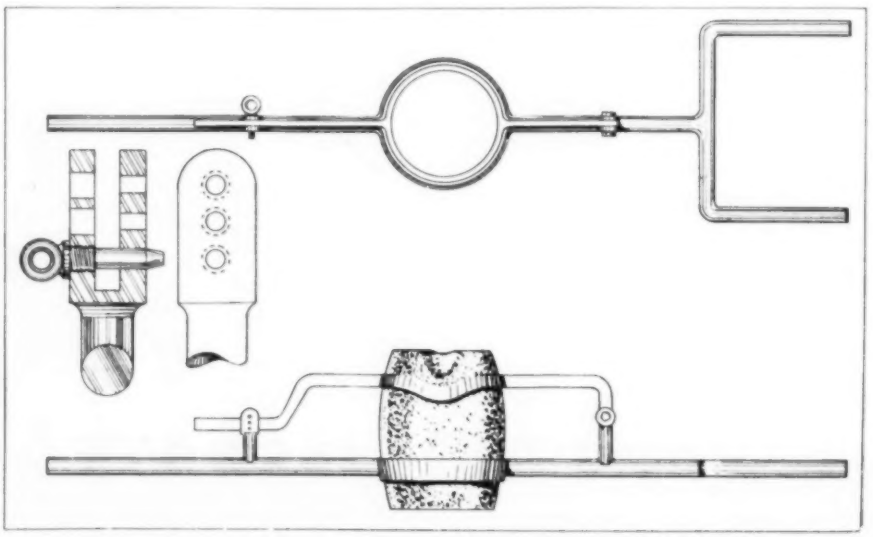
The tensile loads fixed are all in present use and embodied in various B. E. S. A. specifications, except the largest bar. While no difficulty will be met in obtaining the test on the two smaller bars, the largest size bar will not give an equal result due to its size, the slower cooling effect giving a more open center and thus lowering the result. From a large number of actual tests no difficulty has been met if suitable metal is used.

Invents Safety Pouring Crucible Device

By James Pearson

From an economical and safety standpoint the device shown in the accompanying illustration has proved itself of value in actual practice. Crucibles that are poured from a shank in the ordinary manner sometimes tip and spill the contents where they are not wanted. Besides spoiling the mold and wasting the metal, the operator is in imminent danger of being severely burned. This condition usually arises after the crucible has worn to some extent and therefore does not fit as closely in the shank as it did originally. In many foundries the practice obtains of having a third man accompany the two men handling the crucible. His duty is to stand immediately back of the crucible and with the bent end of a skimmer hooked over the top rim of the crucible, prevent it from upsetting during the pouring process. The device shown prevents the crucible from over turning in any position and also does away with the necessity of providing a third man to assist in the pouring.

Two upright posts slotted on top are welded to the shank, one on either side and a few inches back from the crucible opening. One of these posts serves as a hinge and the other serves as a lock for the upper band that is designed to fit around the top of the crucible just below the lip. In practice the upper band is lifted and swung back out of the way. The crucible is lowered into place in the shank, then the band is brought forward, lowered over the crucible and the free end is engaged in a slot in the post shown to the left of the illustration. The post is provided with three pin holes to engage the band at varying heights and to compensate for wear on the crucible. It is apparent that when the crucible is new it will ride higher in the shank than it will after it has been in the fire a number of times. The device is not patented and readily may be constructed by any local blacksmith or machine shop.



ASSEMBLED VIEW OF POURING DEVICE WITH DETAIL OF THE LOCK

Small Charge Is Oxidized By Strong Blast

Question: In a recent attempt to make semisteel in our 42-inch cupola we find that the castings are full of blow holes and any under ½ inch thickness are too hard to machine. The cupola is provided with six tuyeres, 5 inches high and flared laterally to 20 inches. The air is supplied by a positive pressure blower running at 16 revolutions per minute and rated to deliver 28.2 cubic feet of air per revolution. According to theory this is correct since the melting capacity of a 42-inch cupola is 6½ tons per hour, and approximately 196,000 cubic feet of air are required to melt 6½ tons of iron. However, in practice, the speed of the blower varies and, of course, the volume of air delivered varies in proportion. At the beginning of the heat the blower attains a speed of 134 revolutions per minute, then gradually slows down to 114 and then returns to 136 when the furnace is almost empty. The cupola will hold 12,000 pounds of iron when filled to the charging door, but at present we are running light and only melting from 7000 to 8000 pounds a day.

The coke bed is carried 30 inches above the tuyeres and each 2000-pound charge is made up as follows: 800 pounds pig iron, 800 pounds agricultural scrap and 20 per cent steel rails. Analysis of the pig iron shows: Silicon 3.53 per cent; sulphur 0.034 per cent; phosphorus 0.58 per cent; manganese 0.61 per cent. Analysis of scrap is estimated as: Silicon 2.50 per cent; sulphur 0.08 per cent; phosphorus 0.65 per cent; manganese 0.50 per cent. The steel rails show; Silicon 0.20 per cent; phosphorus 0.05 per cent; sulphur 0.05 per cent; manganese 0.50 per cent. From the foregoing and allowing for a 25-point loss in silicon we should anticipate iron of the following analysis: Silicon 2.20 per cent; sulphur 0.08 per cent, phosphorus 0.50 per cent; manganese 1.00 per cent. The high manganese content is due to the addition of 35 pounds of 80 per cent ferromanganese.

Answer: Correct analysis of the material is essential, but it is by no means the only factor that enters into the production of semisteel. A detailed description of the cupola practice involved is entirely beyond the scope of a short article. We suggest that you write David McLain, Goldsmith Building, Milwaukee, for a book on this subject.

However, it is apparent that your blower is delivering altogether too much air and as a result you are getting an effect in your cupola somewhat similar to that which takes place in a bessemer converter. Instead of losing about 25 points in silicon, which is the usual depreciation when a cupola is working normally, you probably are losing 50 or 75 points and that accounts for your hard iron. The amount of air admitted is in excess of what can be absorbed by the coke and the extra air, or more properly speaking, the extra oxygen, unites with the iron and that accounts for the blow holes.

The logical remedy is to slow your blower down to a point where the air supply will be just sufficient to consume the coke between the charges. If you were running long heats with the cupola constantly filled to the charging door your present blowing equipment probably would be satisfactory, but conditions are radically different when the cupola is running on small heats that only half fill the stack. To regulate the volume of the blast you may either change the ratio of the driven wheel and the driver, or you may introduce a blast gate in the main air pipe.

Nonferrous Society Will Meet In September

The fall meeting of the Institute of Metals will be held at Manchester, Eng., Sept. 10 to 13. The proceedings will be opened on the evening of Sept. 10 by a lecture entitled, "The Use of Nonferrous Metals in Engineering," by Sir Henry Fowler. Great strides have been made in developing nonferrous metal uses and the teachings of the war have been applied to the benefit of industry in general.

On Tuesday, Sept. 11, the morning will be devoted to the reading and discussion of papers, after which the members will be entertained at luncheon by the reception committee at the Midland hotel. In the afternoon visits will be paid to several large plants and in the evening members will be received by the vice chancellor and authorities of the University of Manchester when the official opening and inspection of the new metallurgical laboratories will take place.

On the morning of Wednesday, Sept. 12, further papers will be presented and discussed, the afternoon being devoted to a trip along the Manchester ship canal. A smoking concert will be held in the evening. An excursion to Chester has been arranged to occupy Thursday, Sept. 13.

Starts First Unit

Work has been started on construction of the first unit of the foundry for the A. C. Williams Co., Ravenna, O. The first portion is a series of concrete pits above on which a railroad siding is to be laid so that cars can be run directly over them for unloading. The building will be used for the storage of sand and is to be of steel and concrete. Two additional structures will be erected this summer, plans for which now are under way.

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Submerge Trivial for Broader View

GREAT possibilities, far greater than appear on the surface, confront the International Foundrymen's convention to be held in Paris in September. Effort is to be made to adopt an international standard test bar—not to draw up any specification for physical or chemical properties of cast iron, but just to decide on the shape and size of a test bar which will be standard in all countries. The adoption of such a standard bar will not prevent any foundry in any country from using the size test bar it wishes for its own information. Or any country may adopt and use the size bar which it deems best suited to its particular needs within its borders. All that a standard international test bar will mean is that the iron producing countries of the world agreed upon a standard common to all by which the strength of import and export gray iron castings may be measured.

One strong point of difference in the ideas of the United States and Great Britain is the question whether one size test bar shall suffice to represent the iron in all sizes of castings. The British view that different size bars should be required to represent different size castings no doubt is the more logical view, while in this country it is thought that a single size bar fills the requirements satisfactorily and is more expedient. However that may be, the question of whether one or three sizes shall be standardized is of comparatively little importance compared to the desirability of having a standard size test bar for international trade on which all countries can agree and which will serve as a basis for securing test results for a comparison of the iron in castings shipped to foreign countries. Then with a standard test bar the irons can be compared.

After the standard test bar may come the international standard specifications. However, this is not essential, for with the standard test bar the purchaser can make a direct comparison of the irons from different foundries or from different countries. If one country agrees to furnish iron higher in transverse strength than the iron another country can supply the purchaser may make his decision based upon strength and price and other considerations influencing the transaction. Possibly with a means for a direct comparison of results, competing foundries quickly will see the desirability of agreeing on standard physical requirements. Or if one country can guarantee a higher strength iron than the other it can have the advantage it deserves until the others can make iron of as high a standard.

Whether there shall be one bar or three bars should not be such a hard question to agree upon: but if it cannot be decided, at least nothing should stand in the way of agreement on the size of a bar to represent castings of medium section. Surely it should not be difficult to agree upon this, and such agreement would be one step in the direction of unifying the standards of the foundry industry of the entire world. Thus would be begun in a small way for a particular industry what the now defunct International Association for Testing Materials, formally organized in 1895, endeavored to do for all industries in a large way. Possibly slower steps carefully taken and generally agreed upon will prove more enduring than if too much is attempted.

Trade Outlook in the Foundry Industry

MANY exceptions are noted this year in the mid-summer dullness which usually overtakes the foundry industry in August. Stove shops, particularly those in the middle west and centering in the vicinity of St. Louis, western Illinois and in the Detroit district have continued operations this summer, where it commonly has been the custom to close during the present month. Automobile manufacture is sustaining a high rate among the automotive foundries. Steel castings demand has banked up orders sufficient to assure a heavy melt straight through this month and for a period in the future.

Malleables Active

Malleable castings manufacturing plants are busy, particularly those engaged in producing railway sundries. The steady growth in output in this branch of the industry has continued with practically no recession since January, 1922. The department of commerce recently has inaugurated a monthly report on jobbing malleable castings. This shows that the rate of operation as reported by 90 firms in May was 71 per cent and in June was 67.3 per cent of total capacity. These statistics do not include castings which are made for use within a company's own plant or those which are finished and sold as other products. Continued high rate operations seem assured to malleable foundries for the remainder of the year. Jobbing shops making gray-iron castings have experienced a slight falling off in demand, in line with conditions which usually maintain in midsummer. A few of these have picked up since the close of July and the majority expect a fair volume of work by the last of the month.

Prices of Raw Material for Foundry Use

CORRECTED TO AUG. 9

Iron		Scrap	
No. 2 Foundry, Valley	$26.00 to 27.00	Heavy melting steel, Valley	$18.00
No. 2 Southern, Birmingham	23.50 to 24.00	Heavy melting steel, Pitts.	16.50 to 17.00
No. 2 Foundry, Chicago	27.00 to 27.50	Heavy melting steel, Chicago	16.50 to 17.00
No. 2 Foundry, Philadelphia	25.76	Stove plate, Chicago	16.50 to 17.00
No. 2 Foundry, Buffalo	25.50	No. 1 cast, Chicago	21.00 to 21.50
Basic, Valley	24.00 to 25.00	No. 1 cast, Philadelphia	20.00 to 21.00
Basic, Buffalo	24.00 to 24.50	No. 1 cast, Birmingham	19.00 to 20.00
Malleable, Chicago	27.00 to 27.50	No. 1 cast, Buffalo	19.50 to 21.50
Malleable, Buffalo	25.00	Car wheels, iron, Pittsburgh	18.00 to 18.50
Coke		Car wheels, iron, Chicago	19.50 to 20.00
Connellsville foundry, coke	5.00 to 5.75	Railroad malleable, Chicago	22.00 to 22.50
Wise county foundry, coke	7.00 to 7.50	Agricultural mal., Chicago	20.00 to 21.00
		Malleable, Buffalo	20.00 to 21.00

Iron Buying Continues

Purchases of pig iron, running into the fourth quarter are increasing, while in the main prices continue at a steady level with some tendencies downward, notably in southern grades. Foundry stocks, bolstered by odd lot buying for prompt shipment show little change and with a continuation of the present melt, ample iron is on hand for immediate needs. Foundry coke sales are limited though somewhat larger than during July. A few contracts for 72-hour fuel, ordered at $7.50 ovens and on which deliveries have been deferred by the customers have been adjusted on a basis of $7 and this price has been offered for the remainder of the year. Cast-iron pipe demand continues at a higher rate than usually is encountered this late in the season. Foundries making pipe, in general cannot give delivery under three or four months. Eastern demand and inquiry for cast pipe are increasing. Oil field supplies are selling more slowly due to the decline in oil prices and the tendency to control production and curtail extensions. Building construction has encountered the mid-summer recession, but despite this fact, radiator and furnace interests share with the stove manufacturers in the comfortable back-log of orders assuring continued foundry operations.

Producers Optimistic

Although 23 blast furnaces went out of operation in July, pig iron producers are hopeful, as is indicated by the number of furnaces which were banked instead of being blown out. Banking, of course, indicates resuming operations at an early date. According to statistics compiled by the *Iron Trade Review*, a total of 3,684,631 tons of pig iron was produced in July, exceeding the June output of 3,667,868 tons, due to the additional working day. On a daily average basis, June led with 122,262 tons which exceeded the past month's average of 118,859 tons by 3403 tons per day. Merchant pig iron made in July totaled 900,946 tons, registering a gain of 1394 tons over the June production of 899,102 tons. On a daily basis, the average for July was 29,048 tons of merchant iron, a drop of 922 tons under the June daily average of 29,970 tons. The total number of blast furnaces active on the last day of July was 299, a loss of 23, compared with the June 30 total of 322. During July three merchant furnaces were blown in and 11 were blown out or banked. Shipping conditions are highly satisfactory, as is indicated by Alabama iron reaching northern Ohio within five or six days of its shipment from the furnaces. A new high record for freight loadings was set during the week of July 21. A total of 1,028,927 cars loaded in one week excels the previous high mark for the week of June 30 by about 7000 cars. This again is indicative of continued demand for all classes of railway castings. Foundry conditions in Canada are satisfactory, averaging in the neighborhood of 80 per cent in all classes of shops, with the same difficulty reported in securing skilled workmen that is noted among heavy castings plants in general. Boiler and heating sundry foundries are entering their busy season.

Brass Shops Busy

Foundry operations in nonferrous lines are well maintained. A few jobbing foundries serving automobile manufacturers have encountered a lull, but railway brass goods, domestic sundries and plumbing goods support a high rate of operation. Prices for nonferrous castings, based on New York quotations in the *Daily Metal Trade* of Aug. 8, follow: Castings copper, 14.00c to 14.12½c; electrolytic copper, 14.25c to 14.37½c; Straits tin, 38.87½c to 39.00c; lead, 6.75c; antimony, 7.62½c; aluminum, No. 12 alloy, open market, 22.00c to 23.00c. Zinc is 6.15c, E. St. Louis, Ill. Daily average prices for July, follow:

(New York Quotations)

Castings Copper	Electrolytic Copper	Lead	Tin Straits	Antimony	Aluminum 98-99	Zinc St. Louis
14.308	14.646	6.316	38.499	7.091	26.0	6.08

Comings and Goings of Foundrymen

LOUIS W. OLSON has been elected vice president of the American Foundrymen's association, by the board of directors, to succeed H. B. Swan who resigned. Mr. Swan's resignation was prompted by a feeling that he could not give the time required by such an office at the present owing to the extensive building program outlined at the Cadillac Motor Car Co., where he is superintendent of foundries and pattern shops. Edward W. Beach has been elected to fill the

L. W. OLSON

vacancy on the board of directors. Mr. Olson, who has been a director of the association since the Rochester convention, June 1922, was born in Wisconsin in 1878. He was graduated from the University of Wisconsin in electrical engineering in 1899. After engaging in construction work for two years, he became connected with the Ohio Brass Co., Mansfield, O., as draftsman. Later he was made factory superintendent, and in 1920 was appointed factory manager, the position which he holds at present. Mr. Olson was president of the American Institute of Metals in 1912 and 1913.

Theodore H. Burke formerly metallurgist for the Isaac G. Johnson & Co., Spuyten Duyvil, N. Y., has been made metallurgist and foundry superintendent for the Otis Elevator Co., Buffalo.

Thomas Murphy has been made castings inspector for the Union Pacific railroad. Mr. Murphy has been employed for the past 17 years by the Northern Malleable Iron Co. St. Paul, Minn.

Major R. W. Chandler, manager of the truck division of the Yale & Towne Mfg. Co., Stamford, Conn. sailed for Europe July 28 to visit England, France, Belgium, Denmark, Sweden, Norway and Holland.

S. Entwisle, for fourteen years associated with the Chas. Walmsley Co., Paper Pulp Engineers, Bury, Lancashire, England, has joined the staff of the company's Canadian branch at Longueiul, Quebec, as foundry superintendent.

James Craig has entered the service of the Chas. Walmsley Co., Ltd., Longueuil, Quebec, Canada, as foundry manager. Mr. Craig has had 21 years experience in American foundries, and received his early training with the Fullarton Co., Paisley, Scotland.

W. E. Dunn Jr., secretary of the Southern Metal Trades association, on Aug. 18 will sail on the LEVIATHAN to attend the International congress of Foundrymen in Paris, which opens Sept. 2. Mr. Dunn will represent the metal trades industry of the South.

Thomas Cruikshank has opened the foundry at Ville La Salle, Montreal, built three years ago by the G. and J. Weir Co., Glasgow, Scotland. Mr. Cruikshank was associated with the parent concern at Cathcart, Glasgow, Scotland, for 12 years previous to removing to Canada.

Edmund S. Gardner, formerly associated with the American Manganese Steel Co. at its plant in Oakland, Cal., and in Chicago, and subsequently in charge of the installation of electric furnaces for the Best Steel Casting Co., San Francisco, at present is in charge of a foundry for the Atlantic, Gulf & Pacific Co., Manila, P. I. Previous to 1920 Mr. Gardner was superintendent of electric furnaces at the South Works of the Illinois Steel Co., Chicago.

E. E. Thum, formerly metallurgical editor of *Chemical & Metallurgical Engineering*, now is associated with the Linde Air Products Co., New York. Prior to his affiliation with *Chemical & Metallurgical Engineering*, Mr. Thum was professor of metallurgy in the engineering college of the University of Cincinnati and he served also as chief engineer of the Great Falls Smelter of the Anaconda Copper Mining Co., and chief civil engineer of the Tooele Smelter construction, International Smelting Co. He also was in the engineering department of the Anaconda Copper Mining Co. Mr. Thum is a mining engineering graduate of the Colorado School of Mines.

Edward W. Beach, newly elected director of the American Foundrymen's association was born in Waterbury, Conn., in 1873, and began his foundry career by organizing the Manufacturers' Foundry Co., of that city in 1900. He was among the first found-

EDWARD W. BEACH

rymen in America to specialize in automotive castings and has served as a director of the National Motor & Accessory Manufacturers' association for six years. During the war Mr. Beach with the rank of captain, was assistant to the chief inspector of production in the air service. In 1919 he was made general manager of the Ferro Machine & Foundry Co., Cleveland, in which position he served until Feb. 1921 when he was elected president of the company. On Aug. 1 of this year Mr. Beach severed his connections with the Ferro company to take other steps not yet announced. He will continue in the foundry business.

A. H. Vollmer, newly appointed Chicago representative for the Domhoff & Joyce Co., Cincinnati, pig iron and coke, has been connected with the company continuously since 1905. He was in the Cincinnati office until 1910 when he

was sent to take charge of the Indianapolis office, remaining until 1911 when he took charge of the Cleveland office. He has been succeeded in Cleveland by George K. Connelly, who has been in the St. Louis office four years. Mr. Connelly took charge of the Cleveland office July 28, just 23 years to a day from his first business venture when he entered the employ of the Charles Barnes Co., Cincinnati, as secretary.

Samuel L. Smith, vice president of the National Malleable Castings Co., Cleveland, sailed for the United States from Southampton on the MAJESTIC, July 26. While in Europe Mr. Smith visited London, Berlin, and other centers on business.

John M. Gray Jr. has been named president of the Gray & Dudley Co., Nashville, Tenn., which operates two large foundries. He has been vice president of the company since 1895, and in his new position succeeds R. M. Dudley who has been named chairman of the board of directors.

Frank M. Livingstone, Springfield, Mass., has been elected president and treasurer, and John W. Sarles vice president of the Connecticut Electric Steel Casting Co., Springfield, Mass., and Hartford, Conn., recently incorporated for $875,000.

Robert E. Newcomb, manager of the Dean works of the Worthington Pump & Machinery Corp., Holyoke, Mass., has been appointed chairman of a Massachusetts central western coal storage committee to function in Hampden, Hampshire and Franklin counties relative to coal storage problems. A. B. Reynders of the East Springfield, Mass., plant of the Westinghouse Electric & Mfg. Co., is also a member of the committee.

Cheapens Core Sand Mixtures

(*Concluded from Page 670*)

tion of water in the mold. Practically all the cores would be sprayed with paper mill by-product water of the proportions given, and as most of the cores made of oil sand would be small they would be dried at a temperature of 500 degrees Fahr. in an oven through which an excessive amount of air was passing. Corn flour binder cores would be dried in ovens at a temperature unless they were rather large, and the pitch cores would be dried in ovens at a temperature of 450 degrees Fahr. The amount of air passing through the ovens for the last two cases would not necessarily be as great as in the first.

The percentage of core binders to be used in these cores is not given owing to the fact that this materially changes due to the sand used and to the amount of heap sand available, and used. Any foundryman should be able to determine this for himself.

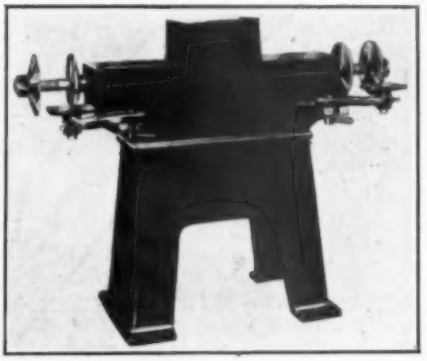
Cores taken from the coremakers' benches should be regularly tested for tensile strength by a simple testing machine, a sketch of which is shown in Fig. 9. Such tests would catch errors in mixing, and changes in the quality of core binders also would be indicated. The testing machine also could be used to test out numerous new mixtures which are constantly being brought to the foundryman's attention.

Sand Tests Available

While the methods of testing molding sands as recommended by the joint committee of the American Foundrymen's association and National Research council have not been issued in printed form, mimeograph copies fully describing the apparatus used and the methods of test operation may be obtained by writing to C. E. Hoyt, the secretary, 1012 Marquette building, Chicago. The methods described cover tests for bonding strength, fineness, permeability and chemical analysis.

Build Heavy Floor Grinder

A new line of grinders has been put put on the market by the St. Louis Machine Tool Co., St. Louis. The arbors are large and have an extra coarse pitch square thread. It is claimed that the best grinder practice favor the transfer of wheels to machines of higher speed rather than the use of cone pulleys, this practice is followed, altho the machine may be fitted with a cone pulley if specified. Babbitt bearings are used throughout and lubrication is assured by the use of the well-known principle of chain splashers. The oil reservoirs are drained from the back and are said not to overflow. The counter-



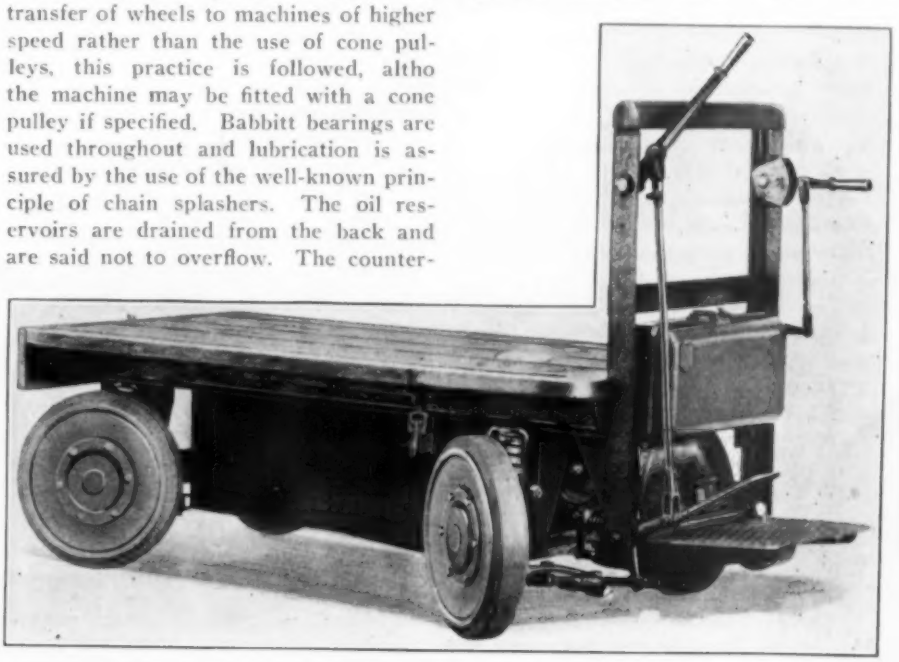
HEAVY DUTY GRINDER DESIGNED FOR BELT DRIVE

shaft is of the self-aligning, split-babbitted, ring-oiling type, with self oiling loose pulley. Wheels may be mounted on either end of the arbor and rests are provided for each wheel. The machine is heavily built and painted with an oil-proof paint.

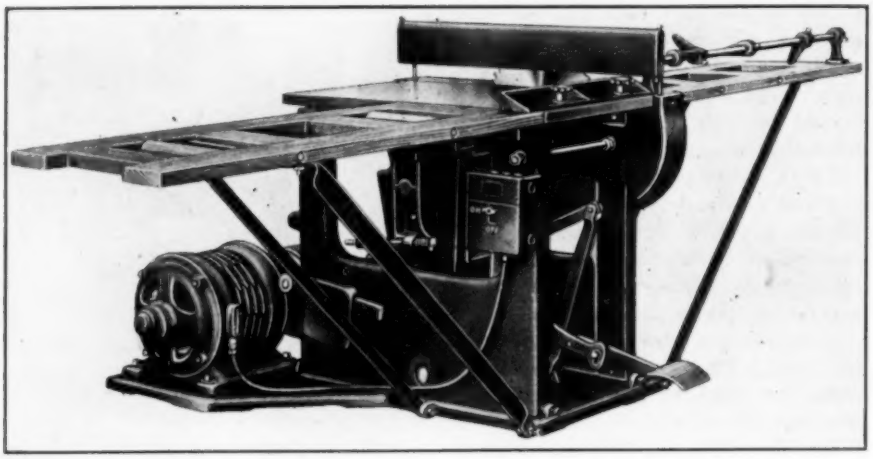
Develops High Platform Utility Truck

A new high platform general utility truck recently has been introduced by the Yale & Towne Mfg. Co., Stamford, Conn., which meets the general requirements for economical intraplant movements of materials. A side view of the truck is shown in the accompanying illustration.

This truck handles miscellaneous units of material which can be placed on the platform by hand, by chain block, electric hoist, ship's tackle or overhead crane service. Auxiliary equipment designed for it includes a gravity dump body for handling loose material and an electrically operated swinging boom crane. It is



HIGH PLATFORM TRUCK WHICH HAS PARTS INTERCHANGEABLE WITH OTHERS OF SAME SERIES



THE SAW MAY BE FITTED TO DO RIPPING AND MITER GAGE WORK

claimed that the large wheels and full spring suspension permits efficient operation over rough surfaces, while ease of control reduces handling costs in narrow aisles and congested spaces.

The machine has a small number of parts, all parts being accessible and grouped into self contained major units. The spur gear unit power axle has shown a high efficiency throughout the operating range. The majority of single parts and unit assemblies in this model truck are standard and interchangeable with all of the other models of this series of trucks which are manufactured by the company.

Designs Under Swing Motor Driven Saw

An under swing cut-off saw designed for use in planing mills, sash and door factories, and other woodworking shops has been put on the market by the Oliver Machinery Co., Grand Rapids, Mich. The frame of the new machine is built up of cast iron units, bolted together. The table, also of cast iron is 22 inches wide, 36 inches long, and 33 inches high. Detachable wood extensions are supplied which give a working surface 121 inches long. The right hand extension is fitted with a stop gage which may be set for varying lengths. A saw arbor of high carbon steel 1 3/16 inches in the bearings, 1⅛ inches where the saw is applied is mounted in self-oiling, babbitt-lined bearings.

The swing frame is controlled by a foot treadle and a counterweight and spring are said to make it practically automatic, leaving the hands free to handle the material. An adjustable stop rod enables the operator to make the swing long or short. The stop is said to automatically return the saw for another stroke. The machine is equipped with a belt idler, saw guard and saw dust chute and may be fitted to do ripping and mitre gage work.

Air Compressor Driven by Synchronous Motor

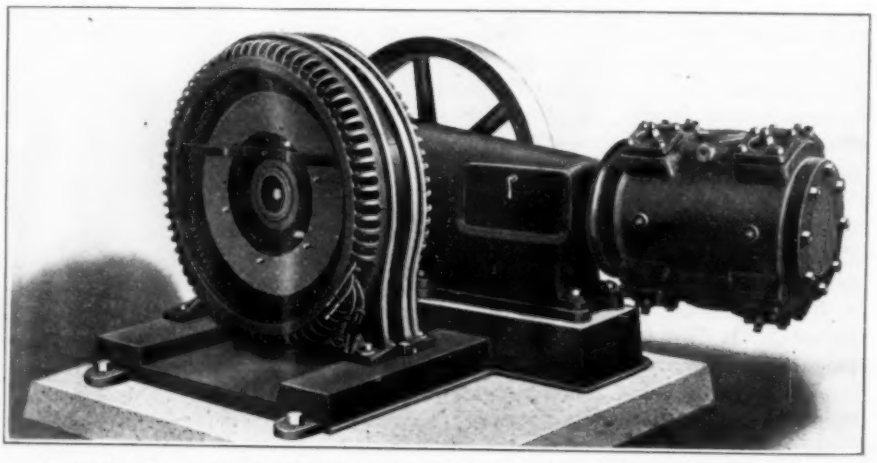
Efficiency and compactness are outstanding features claimed for an air compressor unit recently developed by the Pennsylvania Pump & Compressor Co., Easton, Pa., and shown in the accompanying illustration. The compressors are built in single and two-stage in several sizes up to and including a machine with a piston displacement of 600 cubic feet of air per minute. The unit shown in the illustration, with a cylinder diameter of 10 inches and a stroke of 9 inches has a piston displacement of 240 cubic feet of free air per minute. It is direct connected to a 40-horsepower synchronous motor running at a speed of 300 revolutions per minute.

The motor which replaces the usual belt wheel is mounted on one end of the crank shaft and the fly wheel is mounted on the other end. No outboard bearing is required since the crank shaft is supported on the two main bearings of the compressor.

The motor is controlled by a special switchboard which overcomes difficulties sometimes experienced in starting synchronous motors. The motor is started or stopped by a single push button. When the starting button is pressed, the motor starts in the usual manner as an induction motor and when it attains its rated speed, the synchronous element automatically is cut in. In addition, the compressor may be fitted with a pressure control, which will automatically stop and start the motor as the air pressure rises and falls. It is stated that a synchronous motor running under partial load is such an economical feature of the power factor that it is desirable to run the motor continuously and control the air through the usual pressure control.

Makes New Type Cooler

A new water cooler has been developed by the Century Brass Works, of Belleville, Ill., which may be attached to a municipal water supply to supply cold water. It consists of a cylindrical tank with a cork lining in the upper part of which ice is placed. The melted ice percolates through the perforated section which divides the cylinder and is circulated over a copper coil directly connected with the water supply and leading to the bubbler. The copper coil is made of tube copper plated with tin on both sides to lessen oxidation. The water from the bubbler, as well as the water from the ice, when drained, is conducted directly to the sewer. The ice water does not come in contact with the water cooled, and the coils are sufficient in number to insure thorough cooling. The bubbler has a self-closing, stop cock designed to eliminate useless waste of water. It is particularly adapted to use in factories, shops, offices and buildings. The estimated consumption of ice as stated by the manufacturers is less than one pound per capita a day.



THE CRANK SHAFT IS SUPPORTED ON THE TWO MAIN BEARINGS

Season's Slack Engulfs Sales

Midsummer Proves True to Form in Foundry Equipment Contracts, Though Inquiry and the State of Castings Demand Presage Increased Demand in the Fall

KEEPING step with traditional practice, castings manufacture has slowed down in many lines during the early weeks of August. The same seasonal effect is apparent in foundry equipment sales which are not so brisk as during the past few months, but despite this, inquiries are large and prospects for the fall months are promising. The second quarter of the year is reported as highly satisfactory, when compared with last year and also with 1921. Cleaning room machinery and supplies and waste recovery apparatus have been moving freely. Among recent sales of cinder mills by the W. W. Sly Mfg. Co., Cleveland, are units which will be installed by the American Radiator Co. at Bayonne, N. J., and the Forest City Foundry & Machine Co., Cleveland. The Hardwick Stove Co., Cleveland, Tenn., is contemplating the construction of a new foundry, independent in every respect from the present plant. C. L. Hardwick is secretary and treasurer. The Owens Bottle Co., Toledo, O., has purchased a barrel type sand blast unit from the Pangborn Corp., Hagerstown, Md.

Inquiry Prevalent in Eastern States

FOUNDRY equipment dealers in New York are a unit in reporting inquiry is better than in the last few months, but buying is slow and the situation is dull so far as actual new business is concerned. Many manufacturers of equipment for foundry use are working at full speed, some with two turns, to make deliveries on material sold early in the year. In cupolas, ladles, cranes, tumblers and other heavy equipment, a lull in actual buying is the outstanding feature. A large supply house recently made a thorough canvass of the New England situation in the foundry industry and found it rather spotty. Most founders believe the present castings inquiry will result in brisk buying in the fall and that new orders will be in hand before the present heavy order books have been worked out. Already binders and facings are being purchased for fall use. A maker of cupolas finds much competition from second hand equipment coming on the market late. This restricts the market for new cupolas. The Wheeler Condenser & Engineering Co., 149 Broadway, New York, has bought a 20-ton helical geared ladle from the Whiting Corp. This maker also has sold a cupola to the Charles Parker Co., Meriden, Conn., and two bottom-tap ladles to the General Electric Co., for its Schenectady plant. The National Boiler Co., Garwood, N. J., H. & H. Foundry & Machine Co., Inc., Stamford, Conn. and Pratt & Letchworth, Buffalo, have purchased dust arrester and sand blast equipment from the Pangborn Corp, Hagerstown, Md.

West Notes Slight Improvement

SLIGHT increases are reported in sales of foundry equipment out of the Chicago district. Apparently there is a large amount of buying pending, but this is not sufficiently developed to bring foundries into the market along extensive lines. Sales of cupolas have been the feature of the recent trading. The Whiting Corp. sold two cupolas to the Ford Motor Co., Detroit, and two cupolas to the Glamorgan Pipe & Foundry Co., Lynchburg, Va. The American Cast Iron Pipe Co., Birmingham, Ala., bought a blower and a new cupola. The Southern Wheel Corp., St. Louis, took a 72-inch cupola and a blower and other equipment. The Bemiller Foundry & Machine Co., Belleville, O., bought a 48-inch cupola. The Southern Manganese Steel Co., St. Louis, took a 42-inch cupola. P. H. & F. M. Roots Co., Connersville, Ind., among other sales has contracted for blowers for the Western Electric Co., Chicago; the Southern Wheel Corp., St. Louis; and Alfred Herbert, Ltd., Hamilton, Ont. The Pettibone, Mulliken Co., Chicago, recently has bought rather extensively for foundry rearrangement. Purchases include a blower, a large number of flasks and considerable equipment from Link-Belt Co., Chicago. The Whiting Corp. sold six 1500-pound crane ladles to Wilson Foundry & Machine Co., Pontiac, Mich., two 9-ton, bottom-pour ladles, to the Erie Forge Co. and a 10-ton ladle to the General Electric Co. The American Sash Weight & Foundry Co., Davenport, Iowa, bought a 5-ton hand operated crane, a 2-ton jib crane and a 1-ton elevator from the same interest. The Michigan Malleable Iron Co., Detroit, has purchased four barrel-type sand-blast machines from the Pangborn Corp., Hagerstown, Md. Phillips & Buttorff Mfg. Co., Nashville, Tenn., has contracted for core ovens with the W. W. Sly Mfg. Co., Cleveland. The Western Malleables Co., Beaver Dam, Wis. has purchased ten tumbling mills from the same firm.

Pittsburgh District Encounters Seasonal Lull

FOUNDRY equipment sellers in the Pittsburgh area find themselves in the midst of a dull period which is no more than usual at this season of the year due to vacations, and the customary slackening in foundry operations. In some directions there is a slackening of foundry operations, but not in any one case is it sufficient to cause worry. The consensus of opinion is that the fall will see the resumption of full activity with a commensurate increase in foundry equipment buying. Several inquiries are before the trade and a few sizable equipment installations are in prospect. The largest of the latter is that of the Standard Sanitary Mfg. Co. at Baltimore which will require several cupolas, a large number of molding machines, tumbling barrels, sand mixing, cutting and handling equipment, cranes, and in fact a complete layout for a large modern foundry consisting of several buildings, in all 2100 feet long, some 175 feet wide and others 200 feet wide. The first unit on which work will commence Sept. 1 will cost $3,000,000 with equipment. The Standard Sanitary Mfg. Co. at New Brighton, Pa., is considering some changes in its cupola equipment; bottom sections probably will be bought. The A. M. Byers Co., Girard, O., likewise has been considering some cupola installations, but is understood to have indefinitely postponed the matter of its purchase. The Westinghouse Electric & Mfg. Co., Trafford City, Pa., has closed on a bottom tapped steel ladle, 3500-pound capacity, with the Whiting Corp. Inquiries have fallen off considerably in connection with molding machines although a few still are current. While several purchases lately have been recorded, no individual item is sufficiently important to command much attention. As is true during the largest years of the molding machine industry's history, August is a quiet month and this year is no exception. However, manufacturers know of some buying

which will materialize in September. Recent installations of electric furnaces by the Pittsburgh Electric Furnace Co., Pittsburgh, include the following: Vulcan Iron Works, Winnipeg, Canada; Piston Ring Co., Muskegon, Mich.; Standard Semisteel Foundry Co., Clinton, Mo.; Sutton, Steele & Steele, Inc., Dallas, Tex.; Texas Steel Co., Ft. Worth, Tex.; Cyclops Steel Co., Titusville, Pa.; Florida Machine Works, Jacksonville, Fla.; Baldwin Locomotive Works, Philadelphia; Bethlehem Steel Co., Chile; American Well & Prospecting Co., Corsicana, Tex., and the Eastman Kodak Co., Rochester, N. Y. It is expected that the United States Cast Iron Pipe & Foundry Co., Burlington, N. J., will enter the market for steel foundry equipment for the foundry it is erecting at Scottdale, Pa. Since the general contract for a 50 x 200-foot foundry has been awarded the C. Hass Co. by the Jamestown Malleable Products Co., Jamestown, N. Y., a list of equipment requirements is expected shortly. The May Tray Corp., York, Pa., is expected to make some sizable purchases of foundry equipment for its new foundry comprising three buildings. The Pangborn Corp., Hagerstown, Md. recently sold sand blast equipment to the Novelty Iron Works, Lock Haven, Pa.

What the Foundries Are Doing

Activities of the Gray Iron, Malleable, Steel and Brass Shops

The American Car & Foundry Co., Chicago, has purchased a site, 240 x 250 feet.

The Midway Foundry Co., Burlington, N. C., plans to rebuild the part of its plant which recently was damaged by fire.

The plant of the Toronto Foundry Co., 1884 Davenport road, Toronto, Ont., recently was damaged by fire.

A. E. Hageboeck, 115 Twenty-first street, Moline, Ill., plans the erection of a foundry building, one story, 40 x 90 feet, to be constructed at an estimated cost of $10,000.

The Globe Brass Mfg. Co., 5532 Perkins avenue, Cleveland, plans the erection of a new plant building to include a machine shop and foundry.

A permit has been granted the Frank Foundries Corp., Davenport, Iowa, to erect an addition to its plant at an estimated cost of $10,000.

Capitalized at $50,000 the Climax Mfg. & Foundry Co., Guttenburg, Iowa, recently was incorporated by M. Gilbert, Emil Ihm, M. C. Mintzlaff and J. P. Eckart.

The Great Western Smelting & Refining Co., Chicago, is constructing a warehouse and smelting plant on Russell street, Detroit. J. B. Newman is manager and Albert Kahn, Detroit, architect.

Capitalized at $500,000, the Reliance Pump & Machine Co., Baltimore, recently was incorporated to engage in the manufacture of pneumatic pumps. Incorporators include E. J. D. Cross.

The Central Brake Shoe & Foundry Co., Chicago, has about half completed the erection of its $100,000 plant being constructed at 5330-42 West Sixty-sixth street, Chicago. The company, which is a new organization, will engage in the manufacture of brake shoes and will do a general foundry business. Frank Van Inwagon is president of the firm.

Construction of a 1-story addition to its brass foundry, 60 x 60 feet, has been started by the Hedderich Bros. Co., Evansville, Ind.

The Wyoma Brass Foundry, Lynn, Mass., has been organized to engage in the manufacture of bronze and aluminum castings at 120 Broadway, Lynn. Incorporators of the company include Anna and George Seidler.

Florida Machine Works has started work on the construction of a steel foundry at Jacksonville, Fla., to be built at an estimated cost of $200,000. Plans include the construction of four units and the installation of an electric furnace, according to F. G. Russell, head of the company. It is understood this is the first organization to undertake the production of steel castings in Florida.

Day-Evans Iron Works plans the establishment at Knoxville, Tenn., of a large mine equipment manufacturing plant. A. B. Day and W. Evans are organizers of the company. Mr. Evans will have direct supervision of the planning and construction of the plant, which will represent an investment of $200,000. A site of 53 acres in South Knoxville has been purchased by the company.

Excavation work has been started on the $150,000 foundry for the Hunt-Spiller Mfg. Co., at 383 Dorchester avenue, Boston. It will be of brick construction, 50 feet high, approximately 135 x 240 feet, and will be built to contain three units. The Charles R. Gow Co. has the contract for the foundation and the C. A. Dodge Co., Cambridge, Mass., the general contract. Andrews, Rantoul & Jones, Boston, are engineers in charge of the work.

Sale of the foundry and shops of the Oliver Rim Co., Atlanta, Ga., for $85,000 to a syndicate headed by W. Woods White, of Atlanta, recently was ordered by the federal court in Atlanta. The new owner will take possession immediately and will continue operation of the plant. A new company will be formed, with Mr. White as president. J. T. Rose, of Atlanta, who has been in the iron and steel manufacturing business in Atlanta for many years will be associated with Mr. White in the project.

Erection of a factory building is planned by the Norwalk Enamel Products Co., Norwalk, O., which recently was incorporated with a capital stock of $500,000. The plant will contain 70,000 square feet of floor space and will house six furnaces. Vitreous enameling of all kinds will be engaged in and the company is in the market, and desirous of hearing from manufacturers of equipment, needed in an enameling plant. Officers are: President, F. W. Cook; vice president, Thomas F. Adkins; secretary, Frank Dudley, and treasurer, E. W. Taylor. Temporary offices are being maintained at 214-215 Citizens National Bank building, Norwalk.

New Trade Publications

OIL BURNING EQUIPMENT—Tate-Jones & Co., Inc., Pittsburgh, has issued a 12-page illustrated bulletin in which oil burning equipment is described and illustrated. This includes oil systems, oil heaters, blowers, strainers, burners, blast gates and other supplementary equipment.

WOODWORKING MACHINERY—The Oliver Machinery Co., Grand Rapids, Mich., has published a 16-page illustrated booklet in which portable woodworking machinery is described and illustrated. This includes saws; planer and joiner; knives and cutter heads; disk sanders; oscillating spindle sanders; wood trimmers; oilstone tool grinders; patternmakers' and woodworkers' vises, etc.

ELECTRIC CRANES AND HOISTS—The Northern Engineering Works, Detroit, has issued three bulletins of four pages each describing its different types of cranes and hoists. In some models the hoist is controlled from a cab which is connected to and travels with the hoist; in others it may be controlled from the floor by means of cords attached to the controller levers. The cranes and hoists are equipped with motors of a standard make, completely enclosed, and wired for either alternating or direct current. The hoists are made either for a monorail or a chain. The adaptability of the hoists and cranes to fit the needs of a foundry, steel plant, or any industrial warehouse where heavy material must be handled with facility is the aim of the manufacturers.

TRAVELING GRATE STOKER—An 8-page bulletin recently published by the Combustion Engineering Corp., New York, describes the operation of the traveling grate stoker as manufactured by it. The stoker consists of an endless moving grate, driven by an electric motor geared to the proper speed. Because the entire grate area of the fire changes at intervals, the grate serves the purpose of a feeder for the fire as well as a shaker for the ashes, which are caught in a box placed between the upper and lower sections of the grate. The grate is made so that a fine stream of air is drawn for the combustion. According to the manufacturers the driving of the grate is noiseless and without shock and can be accomplished by a 1-horsepower motor in the case of the smaller stokers and from 1½ to 3 horsepower in the larger at maximum speed.